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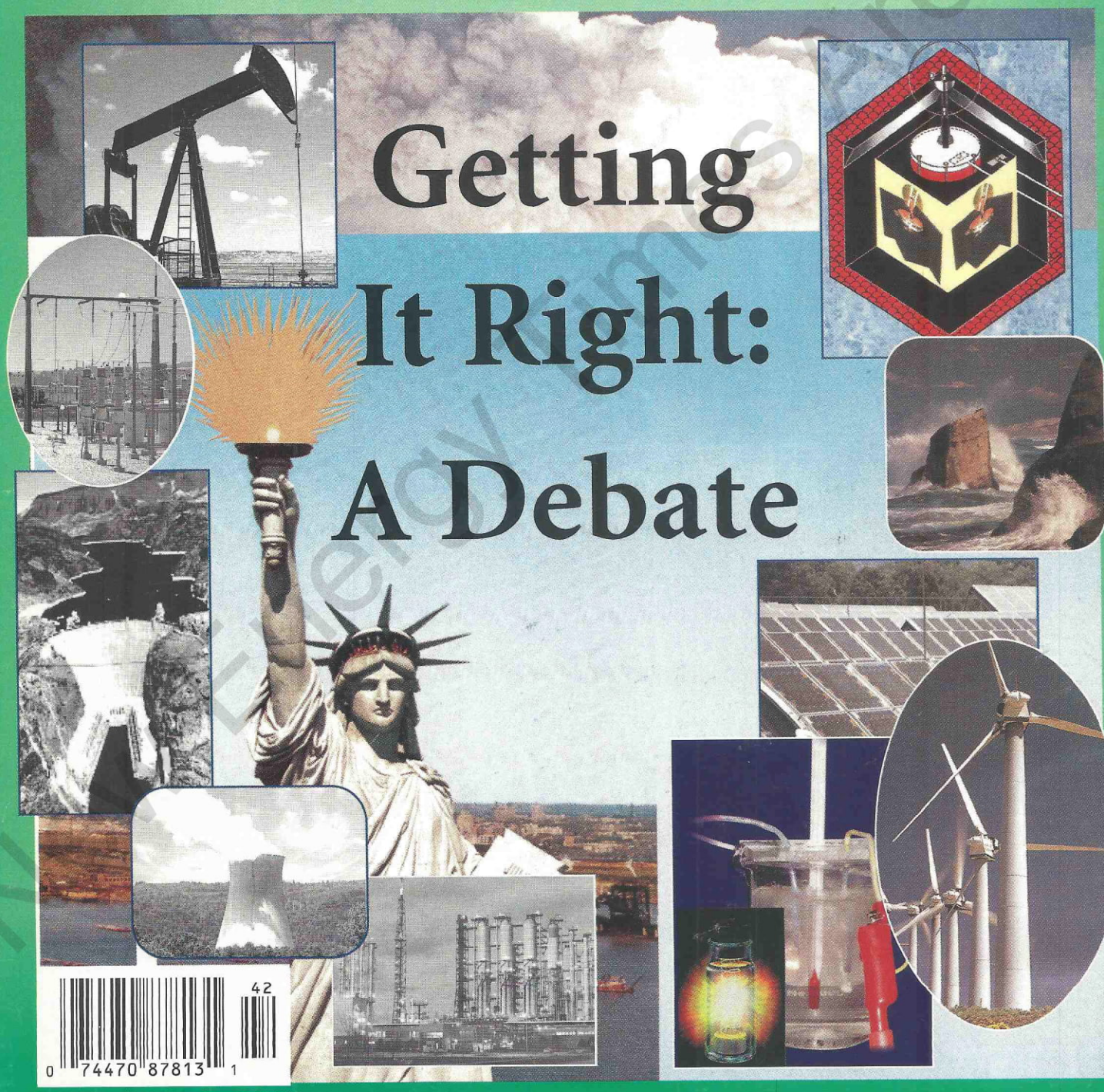

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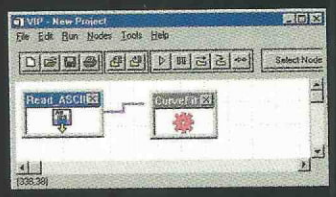

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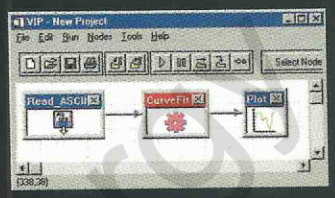

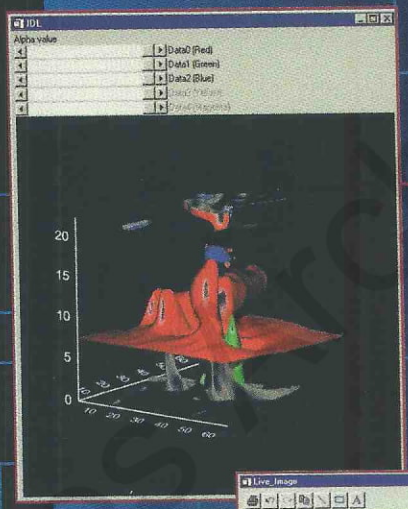

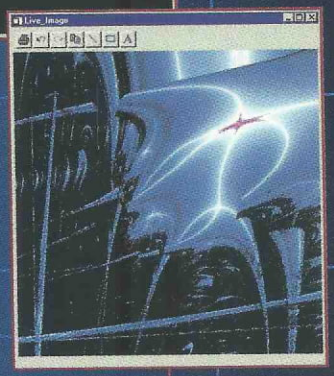

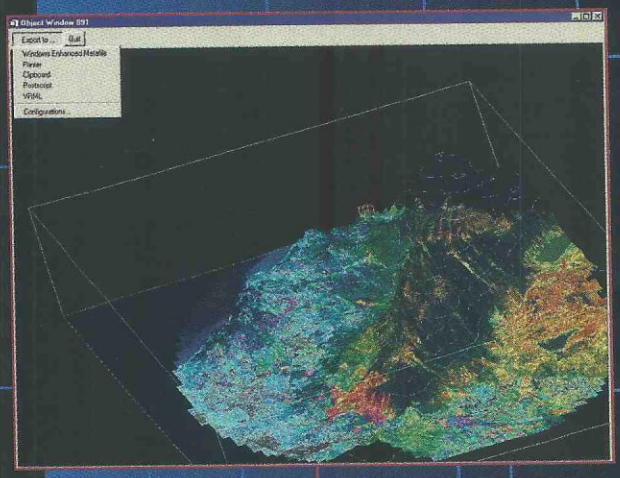

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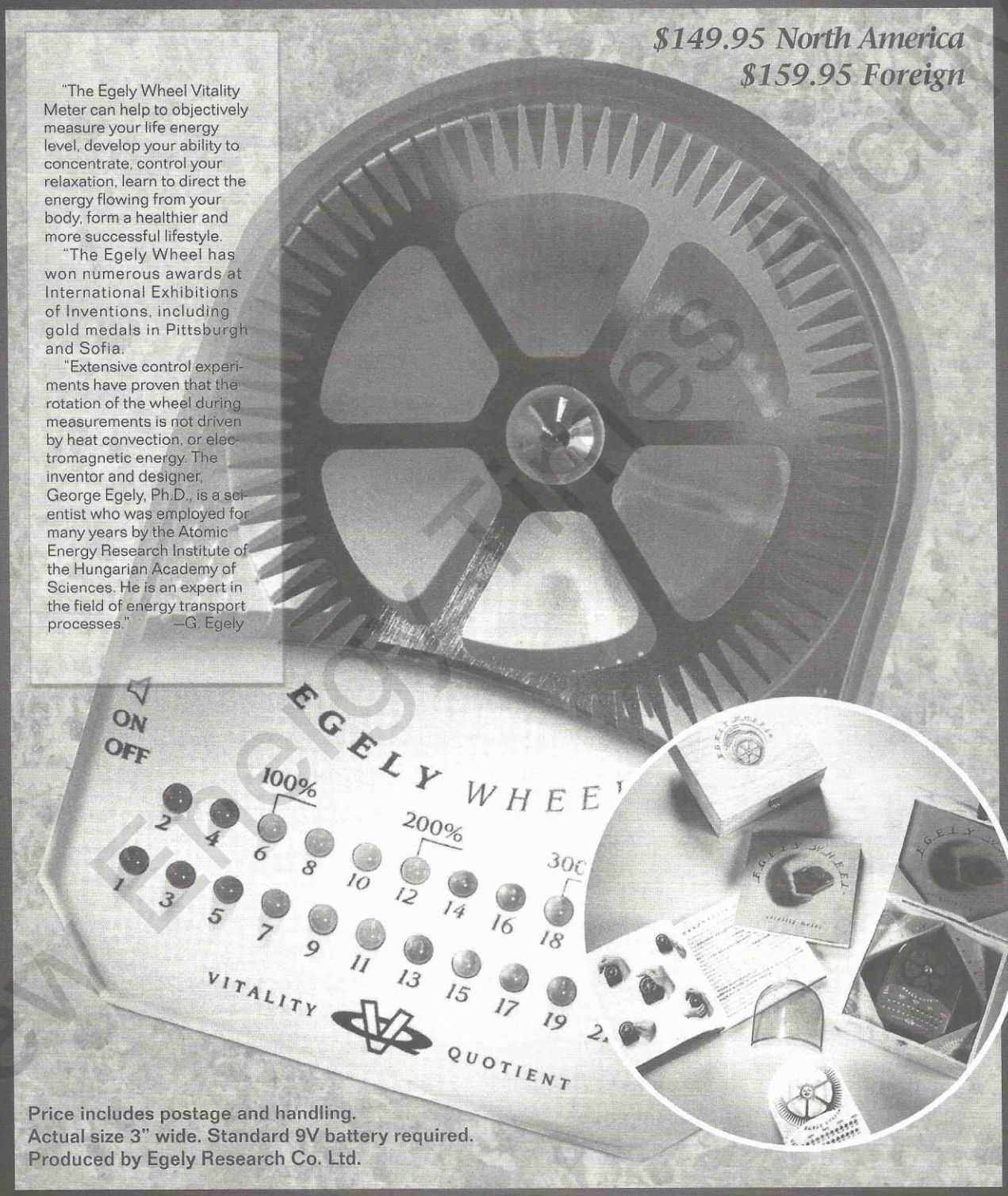

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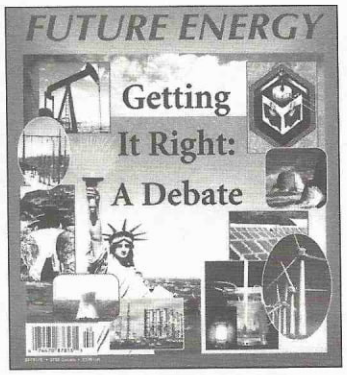

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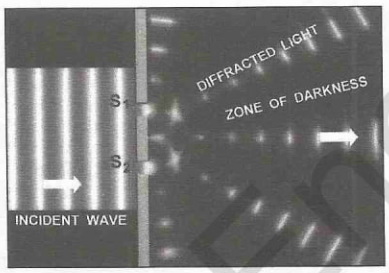

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Editor-in-Chief and Publisher
Eugene F. Mallove, Sc.D.

Managing Editor
Christy L. Frazier

Contributing Editors
Jed Rothwell (Georgia)
770-451-9890
Susan Seddon (U.K.)
sseddon@infinite-energy.com

Editorial Layout Manager
Joann L. Cheney

Scientific Advisory Board
Dr. Harold Aspden, Southampton, UK
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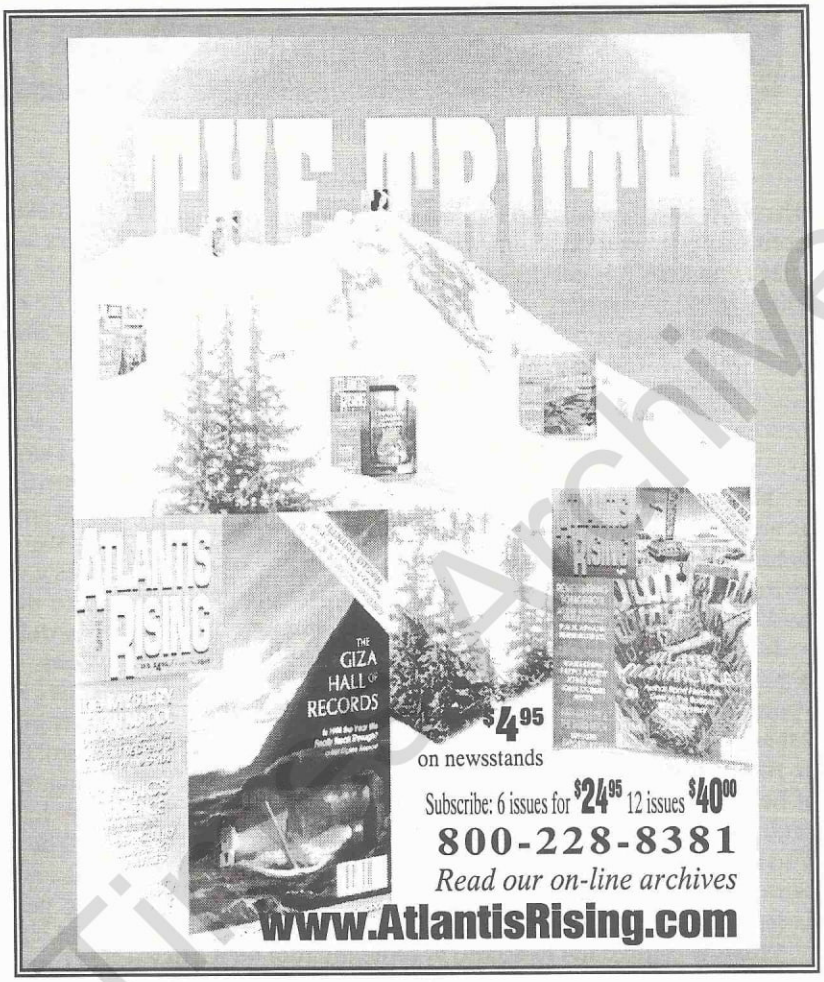

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LETTERS TO THE EDITOR

Words of Encouragement

Three years of reading *Infinite Energy* have been a wonderful continuing education. I pray that the staff of *Infinite Energy* magazine does not get discouraged. The staff and the magazine give so much hope and encouragement to many, many people. Please remain the light at the end of a tunnel.

Carl S. Jacob
Milwaukie, Oregon

More About the Mysterious Schappeller Device

I was interested to read Henry Stevens' article on the Schappeller device (*IE* No. 40). I am probably one of the few living people who has had contact with Schappeller's son and therewith the technology.

In 1946 I was accosted by a Dr. Sergeant, the brother of a psychiatrist, well-known at that time. He entered my room at Imperial College, London, without knocking, and asked me precipitously if I would like to know about atomic implosions. I was puzzled by the phrase and asked him if he meant hot explosion. He insisted that he knew some technology which would give rise to cold implosions. Furthermore, the idea was a dangerous one, and in the wrong hands could lead to massive catastrophe at sea, large areas of which could be suddenly frozen.

What he wanted me to do was accompany him on a trip to Austria, to a place called Auralzmunster, and there we would find a castle in which we would meet Schappeller's son.

After much ado and getting a permit from the foreign office (in 1945 and 1946, one could not take off for Germany, but had to have "permission"), I eventually arrived in Auralzmunster after a hazardous journey from a border town between Germany and Austria; the taxi was an old Rolls Royce tourer. I sat in the back with a large blanket over me, as it was an open vehicle.

Arriving at the castle—which was rather obvious in the down at heel village called Auralzmunster—I knocked at the huge door, raising the large knob and letting it fall several times. Nothing happened, but after three minutes, a window opened high up and a very large key was thrown down. I used it to open the door, went in, climbed the stairs, and eventually was confronted by a man who claimed to be a relative of Schappeller. Before I got into the castle, I had met Dr. Sergeant, who came by a different pathway; in the traditional British way, he only glancingly greeted me with "hello" although we were isolated in such a strange place.

The scientific discussions began immediately at a table, and I remember that a woman was present. I don't remember who she was. The essence of what Schappeller told us was that his father had invented a technology for extracting energy from the atmosphere. He thought the technology to be overwhelming, so he wanted it only in the hands of the British. He trusted them as no other and certainly did not want it in the hands of the Germans or Russians. It was for this reason that he had held off getting financing; he only wanted to have financing by the British, and he would delay development of the technology until that financing came.

Asking questions about the theory of the device wasn't very helpful. It was supposed to be antigravitational and there was something about a shield which was supposed to be an essential part of it. Later I recovered a book called *The Primary Physics*, which I believe I still have and which was supposed to have been written by Schappeller Sr.; it gave some idea of the device, though of course the writing was rather esoteric.

I explained the truth of my mission, that I was there representing the British foreign office (which was true) and I was supposed to make a report on the device.

We had been in discussion for some hours when there was a great noise outside on the stairs, and three men burst into the room. "We're the CIA. We want to know what you are doing here, Doc," one stated. They directed their questions to me rather than to Dr. Sergeant and I simply replied that I was there on behalf of the British foreign office to take part in an inquiry as to the nature of the Schappeller invention. This seemed to satisfy them. They didn't stay for very long, but snuffled around the oak paneled walls a little bit and looked at everyone, and then departed.

The paneled room evidently held a secret door which, at the end of the conversation, opened and a rather slight looking gentleman, dressed in normal clothes, came out and said, "I represent the British Admiralty."

I returned to England and made my report to the foreign office. I said that in order for the thing to be taken seriously, one would have to do a number of things, which I listed, and if this were done, there should be a follow-up of the Schappeller physics and perhaps that something would even come from it.

Three other things happened. In the first, I described what I had gathered of the device to some colleagues at RCA in Princeton, New Jersey, and together we worked out the possibility of tapping the electrostatic field which is between the earth and the ionosphere. This is a field of considerable magnitude—I believe about 100 V per meter—and of course one could think of a car which would have an aerial, say 3 meters above the car, and the potential difference between the top and the bottom of this aerial would be large. The possibility of tapping the energy which this implied, of course, depends upon lowering the air resistance between the top and the bottom. One imagines a nonconductor as the pole, and a wire going from the top electrode to the bottom electrode. The only thing we could think of would be that one could have a device in which there was radioactive materials which would ionize the air between the two electrodes and thus allow the current to flow. We worked it all out mathematically and it came to something quite sensible *if* one could have the device which would ionize the air.

The next thing that happened (around 1965) concerned the fact that I was at this time an avid reader of the German magazine *Der Spiegel*, a kind of German *Time* magazine. I read an article supposedly by Prof. Hellman, who described himself as having "escaped" from the Soviet Union and settled in Brazil. The principal tale which Dr. Hellman had to tell was about a device

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that he had seen the Russians use, which caused an immediate freezing of the sea over a large area. I thought immediately of what Sergeant first talked about—the production of cold instead of heat, an endothermic reaction of nuclear power.

On a later date, I tried to get hold of the article in *Spiegel*, but could never get any satisfactory answer from the magazine headquarters.

Then, some twenty years later, in New Orleans, coming down the corridor of a hotel, I met Sergeant coming in the opposite direction. We spent the evening together over a bottle of champagne and he brought me up to date on the Schappeller situation. He said that he (Sergeant) had indeed eventually found funding for the device which Schappeller wanted to build. He had persuaded a wealthy ship owner (which existed at those times!) to let him have the money, but the donor made one simple stipulation—that there should be associated with the gift a witness to what was done in the building of the machine. Tragically, or perhaps indicating the whole thing was a fraud, Schappeller refused the offer. He said that the machine had to be built in absolute secrecy and he could not brook the presence of a witness.

So, that is the end of the story at that point (around 1980) and that is all I know, in addition to what I read in Stevens' remarkable article. I hope that my own experience, perhaps, contributes something to the knowledge of the situation.

John O'M. Bockris, Distinguished Professor
Texas A&M University (1982-1997)
College Station, Texas

✍ ✍ ✍

MHD Electric Arc Generator

The article by Neal Graneau, Peter Graneau, and George Hathaway (*IE* No. 41) is important. It explains why anomalous heat input in the cold electric arc develops an EMF which enhances the current. As is well known, MHD (magneto hydro-dynamic) action converts heat into electricity, but here we see why it is that the heat generated by the electric arc discharge has a way of regenerating electrical power which augments the discharge current. Over-unity, our "free energy" quest, is in evidence in the reported data.

Owing to my interest in this advance, I offer three comments:

1) We should remember Leon Dragone's research findings on this very same subject. His arc discharge circuit had a light bulb as load resistor and the air gap plus a capacitor, as well as an inductor rather than the secondary winding of a current transformer, but it ran continuously. Dragone (now deceased) claimed that his circuit was converting ambient heat into electricity and presented his discovery at the Hull, Quebec 1988 Planetary Association for Clean Energy conference, which I attended, as did George Hathaway.

2) We still need to understand how the excess energy, as heat input, gets into the arc gap to feed the arc explosions which drive the ions radially outwards in the successive pulsations of the circuit. MHD merely converts heat into electricity. It does not generate that heat. Here I draw attention to the aether's free energy inflow mechanism that I explain at page 64 in my paper in that same issue of *Infinite Energy* (No. 41).

3) In the final paragraph of the "Authors' Response to Commentaries," it is acknowledged that it would be intriguing to apply an axial magnetic field to the arc. The effect of such a field, as found by experiment, is that the sequential pulse discharges divide into several radial arms and follow curved paths depending upon the strength of that magnetic field. I believe that this has little bearing on the "over-unity" energy generation phenomenon. My data source is the 1991 doctoral dissertation of Karl Peter Uhlig (University of Konstanz, published in 1993: ISBN 3-89191-667-1) entitled "Surface Discharges (Lichtenberg Figures) in High Magnetic Fields."

Harold Aspden
Southampton, England

✍ ✍ ✍

Orthodox Physics Mostly Nonsense

I am delighted that *Infinite Energy* is providing a forum for alternative physics. Congratulations on your two excellent issues concerning the Einstein myths (Nos. 38 and 39). Orthodox physics, ignoring so many of the relevant empirical facts, is fundamentally mostly nonsense.

I have sent Dr. Mallove a copy of my book *Advanced Fundamental Physics*. It contains information, not readily available elsewhere, about experiments and theories that may interest your readers.

For example, it is concluded that there is a fixed "luminiferous ether" or "absolute space" in which the one-way energy velocity of light is c. The observed one-way velocity of energy propagation of light c^* is independent of the velocity of the source, but depends upon the absolute velocity of the observer, such that

$$c^* = c - v$$

which explains the Roemer observations, Bradley aberration, the Sagnac experiment, the Michelson-Gale experiment, Conklin's observation of the anisotropy of the 2.7*K cosmic background radiation, and Marinov's two measurements of the anisotropy of the one-way velocity of light in the closed laboratory.

The null Michelson-Morley (M-M) result was predicted by Voigt in 1887 before the experiment was performed. Voigt considered the Doppler effect for light, where the out and back phase velocity is isotropic. The M-M experiment involving interference involves the phase velocity and not the one-way velocity of energy propagation as erroneously assumed by Michelson and others. Voigt's unfortunate mathematical representation of the Doppler effect, for light in terms of space and time instead of for the propagation constant and the angular frequency, led Lorentz to the idiotic conclusion that somehow space and time must actually change in a moving system. Lorentz usurped Voigt's equations and presented them as his own "Lorentz transformation."

Paul Wesley
Blumberg, Germany

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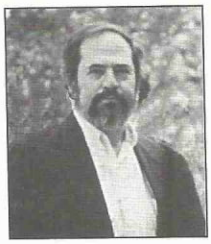
BREAKING THROUGH

On Being Observant. . .and Accountable

by Eugene F. Mallove, Sc.D.



Apart from the unwelcome turbulence, it seemed like a fairly uneventful flight from Boston to Los Angeles. High in the stratosphere, passengers aboard the big jet had settled into the routine of the five-hour transcontinental hop—an unimaginable miracle of science and technology, had this been 1901 when the Wright brothers were still at the hang-glider stage, as Otto Lilienthal had been in 1896 in Germany at his death. But this was a century later, August 1, 2001.

In less than six weeks, an obscene terrorist plot that had been percolating underground for years would kill thousands in New York City, Washington, and Pennsylvania. Lives hung in the balance. Terrorists plotted to take advantage of the miracle of flight, the weakness of steel heated by burning jet fuel, and the force of gravity itself. Aboard that flight on August 1 was much more than a subtle clue about what would happen September 11. And, that clue *was observed*. This flight from Boston was apparently some kind of "dry run" for the day of infamy.

Aboard the flight was an exceptionally sharp man who had attended three years of MIT before leaving to pursue a successful acting career. The Emmy Award winner has appeared to date in more than twenty Hollywood movies ("Contact," "Ghosts of Mississippi," "The Boost," etc.). He was the observer. James Woods is a member the MIT Class of 1969—"Fine '69," the Moon landing class, and about the 100th class to graduate the illustrious "Institute."

For about two decades I have been the secretary of that class; it has been my business to follow the accomplishments, lives, and deaths of classmates and report them in MIT's alumni/ae magazine, *Technology Review*, which bills itself "MIT's Magazine of Innovation." So on Valentine's Day 2002 when I saw the dashing actor-classmate about to be interviewed on the Fox News channel's "The O'Reilly Factor," I pressed the record button on our VCR.

It was the first time *in public* that James Woods had related his remarkable, chilling experience of last August. He told host Bill O'Reilly that he had observed what he considered to be suspicious behavior by four men of evident Middle-Eastern origin, who surrounded him in the First Class section. This was the key part of his revelation: "Without going into the details of what made me suspicious of these four men, although it would have been blatantly obvious to the most casual observer, I took it upon myself to go to the flight attendant and ask to speak to the pilot of the plane. The first officer came out. I reported to him that I felt that the four men. . .and I said 'Can you look over my shoulder to see whom I'm talking about?' He said, 'Uh, yeah. . .' I said, 'I think they are going to hijack this plane, I mean everything they are doing. . .' and I explained to him these details—which I've been asked to keep private, until whatever trials may take place. Their behavior was such that I felt that they were going to hijack the plane. I also said, 'I am very much aware of how serious it is to say on an American aircraft, in flight, the word 'hijack.' So I am saying this because I really have reason to believe that it is true.'" Woods recalled that on the evening of August 1, he commented to his girlfriend and his best friend, "Aside from the terrorists and the turbulence, the flight was fine." "In retrospect," he said, "not such a funny joke."

On September 11, after witnessing the horrific events of that day on television, Woods contacted the FBI. Two agents came to his house at 6:45 a.m. the very next day. He would subsequently learn from them that the pilot and the flight attendant whom he had approached on August 1 each had filed a report about the incident with the FAA (Federal Aviation Administration). Woods said that he has since learned that all four of the men whom he saw acting so suspiciously on his Boston-to-Los Angeles flight were in fact terrorists! Two of them were aboard United flight 175 and American flight 77, which plowed catastrophically into the World Trade Center and the Pentagon. The other two men were also confirmed by the FBI to have been accomplices, he said. Woods observed that none of them had brought carry-on luggage on this long flight, and all seemed profoundly detached and furtive in their demeanor. "I thought that they were either four (undercover) law enforcement officers, or four terrorists," said Woods.

He emphasized that he had not personally contacted the FBI *before* September 11—rumors to the contrary notwithstanding. Still, those FAA reports that were made by the flight crew thanks to his prompting just might have led to investigations that could have upset the September 11 plot. Obviously if an airline passenger made such a report today, it would be investigated with great urgency—and, one hopes, diligence. One can only speculate what might have been had Woods' concerns made it to intelligence authorities prior to September 11 and had those in charge acted on the information.

But what does this remarkable "what if" episode have to do with the topics with which *Infinite Energy* is usually concerned? Answer: Plenty! It dramatizes the importance of being *observant* and the necessity of being responsible and accountable in matters that are of potentially overarching importance. "Be observant!" is not just a homey admonition from your seventh grade science teacher. Mine, a Mr. John Zoukowski, had told us that many times in 1959-60. I believe it sank in.

The comparison is not overdrawn: Think of those who have played a disgusting, dangerous game for the past thirteen years with the painstakingly generated *data* from cold fusion experiments bearing on excess heat and nuclear products. They have wantonly ignored that data and have mocked it mercilessly. These bureaucrats and ossified academics are neither observant nor accountable. And, they are highly irresponsible in their actions and inactions. In many cases their behavior borders on

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criminally irresponsible. Lives too numerous to reckon have already been lost in the outrageous delay in applying adequate human and financial resources to the science and technology of low-energy nuclear reactions.

Like the passengers aboard flying fuel tanks and in buildings threatened by suicidal terrorists, our lives hang in the balance every day. We inhabit a berserk planet in which oil is the currency of criminal dictators and manipulators. Fiery deaths occur every day in the transportation sector. Choking air pollution from the hydrocarbon economy takes lives by the thousands. And, whether or not one accepts the evidence for man-made CO_2-induced global warming, the hypothetical *threat* is there. Wars over the security of the false currency of limitation—oil—consume national treasuries and thousands of lives. Yet there is the data, screaming out from countless pages—ignored, unobserved, ridiculed. The cold fusion data place an *absolute lower limit on the available nuclear-scale, radiationless, pollution-free energy* from a gallon of ordinary water: 300 gallons of gasoline energy equivalent. The energy of all the known oil reserves on Earth from a tiny cubic kilometer of ocean.

Alright, James Woods' actions did not save 3,000 lives in New York City on September 11. But that's not the point; they *could have*. Immigration papers of the plotters could have been checked and travel histories correlated. That might have been just enough to shake up these four, stall for time, and prevent at least this atrocity (if not others that may still come.) What if the pilot and the flight attendant hadn't filed their reports? Then, short of James Woods himself going directly to the FAA or to the FBI prior to September 11, there might not have been any other factor threatening to unravel the terrorist plot.

What if in 1989 the MIT hot fusioneers had stepped back from their arrogance and bigotry and actually thoroughly investigated the anomalous calorimetric data in their possession, which hinted at the reality of the excess heat effect from a hastily constructed Fleischmann-Pons cold fusion cell? [See an account of this travesty in *IE* No. 24.] What if they had been *observant* rather than oblivious? There would have be no "null result" sixteen-author MIT "Albagli *et al.*" paper topping the roster of the DOE Cold Fusion Panel's report in 1989. If not that, then what if President Charles Vest of MIT had actually had enough intellectual curiosity and integrity to get to the bottom of the scandal of press manipulation, lying, and data shifting at MIT, that is, *scientific fraud*? What if any *one* of the twenty-three Panel members had stepped out of line to protest the outrageous rush to judgment? Nobel laureate Norman Ramsey did, but then failed to follow through, signed the report, and has been hiding under a rock ever since. Zero accountability. Ditto for Professor Mildred Dresselhaus of MIT, who *knew and knows* that open questions remain and did nothing about it while in her top DOE science position during the Clinton Administration.

The litany of poor observation and lack of accountability goes on and on. In February 2000, President Clinton's White House asked me for a report on cold fusion, per the urging of Sir Arthur C. Clarke. It was rendered—all 8,500 words (posted at www.infinite-energy.com). No response for ten months and then Clinton's pathetic "thank you" note of January 18, 2001 goes out: "Thank you for your memorandum, 'The Strange Birth of the Water Fuel Age'. . .I was glad to have your insights about the critical challenges in the field of high technology, and I commend your commitment to improving our world. I hope that you will remain involved in the important issues of this new century. . ." Blah, blah, blah. . . Oh please, spare me!

As for the present President, still no response to a nearly identical entreaty to the one sent to Clinton, this time published beginning on the cover of *Infinite Energy* No. 40, post-September 11. Nor do I expect a response, not even a thank you note. A response of *any* kind might mean the inconceivable: bowing slightly to the one simple and unarguably reasonable request to both presidents: "Mr. President, you need do only one thing now: Publicly state that you are going to investigate this matter and then do it." Be observant! Be accountable! Don't give us any money. Don't pass any laws. Just give us the benefit of acknowledging that an important issue needs to be resolved—and the mess that issued from Washington in 1989 will clean itself up. Hordes of previously silent and timid media pundits, who fancy themselves to be high-class science journalists but are mere lackeys of propagandists, will then emerge from dark holes. They will be forced by the simple utterance of those forbidden words—*cold fusion*—to write volumes about it as though it were a new Enron scandal, though it is far worse. We'll give them a ready-made moniker: HeavyWatergate. Go for it! Get your Pulitzers!

In the dim, dark past—for example in the late nineteenth century—being observant in science typically meant watching carefully for anomalies that might open new windows on nature. One such opening occurred when Wilhelm Roentgen was observant and serendipitously discovered X-rays in 1895. It turns out that one A.W. Goodspeed of Philadelphia had inadvertently made an X-ray photograph five years earlier (February 1890), but had not recognized its significance. He was insufficiently observant and held back the progress of science for some five years. That is about the same period it took establishment science to recognize the Wright brothers' flight of December 17, 1903, even though they had operated their flyer for five years thereafter in full public view.

It is a new day. Official Science is at war with anomalies that threaten its foundations. Led by its most egregiously self-satisfied and arrogant branch, Official Physics, its micro-minded buffoonish commentators have a scorched Earth policy for all that is truly new. Let any anomaly, such as cold fusion, challenge its sacred Texts, and it is open season on its discoverers and observers. Science is dead. Scientism reigns.

What happened to cold fusion is but the tip of the larger iceberg of tyrannical suppression—in physics, chemistry, biology, medicine, and cosmology. Cold fusion is a mere pebble on a mountain of new observations that need to be explored. But how to bring that about when the reigning paradigm preaches scientific celibacy: the rigorous *avoidance* of any and all observations that conflict with Space-Time, Big Bangs, Little Bangs, Coulomb Barriers, and the opinions of your local university's Quantum Mechanic? Sorry, I don't have a really good solution to this, short of beating the beast over the head with an irrefutable demonstration device on market. Failing that, one can only try one's best to observe and discern what may be important and true amid the data fog and bombardment by irrelevant stimuli, and to seek others who may listen. ❑❑❑

ERRATA

In the "Breaking Through" editorial of Issue No. 41, part of the text should have read: "Aetherometry demonstrates that what traverses Space is not transverse electromagnetic radiation (and certainly not sensible heat), but longitudinal ambipolar electric [**not *electromagnetic***, which was the error] radiation emitted from the Sun."

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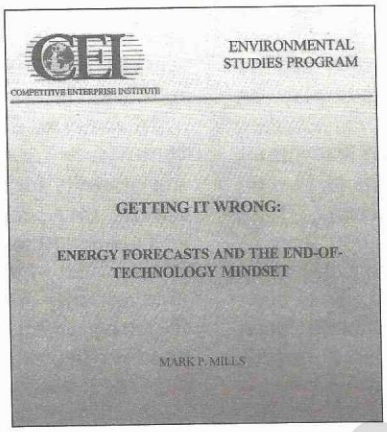
Future Energy: Getting It Right—A Debate

An Introduction by Eugene F. Mallove

In these troubled times, energy is very much on people's minds, but it has been very difficult to free popular thinking from the prison of the hydrocarbon fuel paradigm. Thus the reason for this feature—a *de facto* debate about forecasting future energy and how to "get it right."



Stimulating thinking about *how to think* about the future of energy is truly more important than specific forecasts. So we have cast the issue as a shadow "debate" between one Mark Mills, a physicist and advocate associated with more conventional energy interests, and Jed Rothwell of this magazine, who considers himself at the vanguard of new energy—for him, cold fusion and such conventional renewables as wind energy. The Mills piece existed already, and we have simply reprinted it with no changes. Jed Rothwell's rebuttal takes great exception to Mills' perspective and many of his assertions. Though I see virtues and flaws in the arguments of both sides, as a good "moderator," I'll keep to the sidelines except for this brief introduction.

I share Mills' profound distaste for certain elements of the so-called environmental movement—as examples, the close-minded, well-funded "do gooders" of the Union of Concerned Scientists and "Mr. Nega-watt," Amory Lovins, neither of whom (to their permanent disgrace) have given cold fusion an iota of attention. But unlike Mills, I am no cheerleader for the present corrupt fossil fuel infrastructure—no matter how many innovations in cleaner coal burning or oil extraction it can develop. I see the flaming hell ignited by fuel-laden jetliners crashing into the World Trade Center towers as a regrettable but perfect metaphor for the doomed Fossil Fuel Age. And do not forget for a moment that the terrorists who perpetrated this atrocity were bred in that region of the world where Oil is King and keeps kings in power. Many of these tyrants have ambiguous attitudes toward such terrorism. Dependency on foreign oil has forced us into an unholy alliance with them. But the rock bottom fact, ignored by Mills, is that fossil fuel energy has no hope of bringing up the standards of living for all the peoples of the world. There are just too many of us—already. It is good that Rothwell skewered him on that key point.

The sudden financial collapse of Enron and the ongoing investigation into its management and financial schemes further heightens our sense of energy awareness. The once prosperous, "invincible" corporation, now universally seen as misdirected, is said to have had ready access to halls of the U.S. government to purvey its energy policies—*infinitely* more access than the beleaguered cold fusion science community has had. Should it be so surprising that a mighty corporation could have become so corrupt? Not when one recognizes that another large organization, the U.S. Department of Energy, is utterly brain dead on a matter of highest national importance, namely the necessity for immediate reassessment of its disastrous negative report on cold fusion in 1989. The DOE can fall just as quickly as Enron. All it takes is one new energy commercial development potent enough to give the lie to all DOE's wasteful programs—from fossil fuel research to hot fusion.

On the positive side, Mills does highlight a body of forecasts by environmental and energy modelers that have proved to be seriously and laughably wrong. And to his credit, he does offer this potent statement:

> Are comparable transformations [to the nineteenth century origin of electrical and electromagnetic technology] in scientific understanding and engineering capabilities possible in the future, especially over the long time-frames often considered by global warming theorists? To assume not is to assume that there is nothing fundamental left to discover, a ludicrous notion. And without considering fundamental technology changes, it is inconceivable that energy forecasts for the next two decades, much less half-century-plus, have any credibility.

It would be nice to think that when Mark Mills receives a copy of this issue of *Infinite Energy*, and perhaps some back issues, he will immediately begin to investigate cold fusion science and other emerging science and technology areas, such as the potentially world-changing experimental and theoretical physics on www.aetherometry.com.

Sad to say, that happy change of heart and mind is unlikely to occur, but I hope my prediction is in error. Mills writes, "Many, environmentalists today are doing the equivalent of worrying about finding better lamps to burn whale oil at the dawn of the age of electrical lighting. Better to let science and technology flourish." Indeed, but how can such new science and technology flourish if it is ignored by influential spokesmen who have the power to promote such openness, but whose acts of omission belie their words? Mills writes: "At stake are literally trillions of dollars in net present-value capital assets in today's infrastructure." Certainly not much at risk from the very weak plans of the environmental activists, but the advent of new physics does put the entire world energy infrastructure at risk. A more delightful and realistic prospect is difficult to imagine!

Enjoy and profit from the debate. ❑❑❑

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Getting It Wrong:

ENERGY FORECASTS and the END-of-TECHNOLOGY MINDSET

Mark P. Mills

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Executive Summary

Just two decades ago, every environmental organization and a bevy of widely quoted energy experts predicted, nay practically promised, a bleak future by the late 1990s. They believed universally in an inevitable and rapid decline in the availability of fossil fuels that would create soaring energy prices with attendant economic and social disruption. Many intellectuals immersed themselves in studies, policy forums, and conferences devoted to solving the looming problem of limited resources, especially fossil fuels, and limits to economic growth itself. The predictions emerged from a flood of "peer-reviewed" studies, from computer models and technology evaluations. This pattern should sound familiar. Today, it is mirrored in language and prescriptions associated with adherents of the theory of human-induced global warming.

The track record of techno-forecasts arising from the "energy crisis" of the 1970s is instructive and relevant to today's global warming debate, for it reveals much about how these soothsayers view technology change, compared to the actual nature of change in energy-related technologies. Two decades ago, the rich body of exhaustive and often "peer-reviewed" studies of energy options for leading the nation away from fossil fuels yielded a common theme. Underlying all these prognostications were assumptions about the prospects for technology solving the energy "crisis." How did the predictions fare?

Two things were clear to environmentalists and alternative energy advocates twenty years ago: Oil was disappearing, and electric demand would not, indeed should not, continue to grow. These self-appointed energy experts and environmentalists mounted furious campaigns calling for urgent federal and state funding for alternative energy programs.

The energy forecasts of these relatively recent days-gone-by were characterized by a breathtaking confidence on the part of environmentalists in their technology visions. A review of a large sample of the reports, studies, and articles from two decades ago reveals that virtually all of the media, policy, and regulatory community bought into a view of the near future (our present) that was utterly wrong. A representative sample of forecasts includes:

1981: "Conservative estimates project a price of $80 a barrel, even if peace is restored to the Persian Gulf and an uncertain stability maintained."

"Energy: A Special Report in the Public Interest," *National Geographic*, February 1981

1980: "It is now *abundantly* clear that the world has entered a period of chronic energy shortages that will continue until mankind has learned to harness energy from renewable sources."

Energy Strategy, Union of Concerned Scientists, 1980

1984: "We see electricity demand ratcheting downward over the medium and long term. The long-run supply curve for electricity is as flat as the Kansas horizon."

Amory Lovins, interviewed in *Business Week*, July 23, 1984

1980: "Because saturation levels for most major appliances are achieved, only minor increases in electricity consumption [will] occur."

Energy Strategy, Union of Concerned Scientists, 1980

With regard to these few, but representative, examples of the record: Rather than escalating to over $100 (in 1998 currency) as forecast, oil prices today remain about the same as the 100-year-long average price of about $17 a barrel. Far from experiencing "chronic" shortages, the world is awash in conventional energy. Renewable sources, excluding large-scale hydro—largely reviled by the environmental community—still account for under 1% of U.S. energy supply. As for the flat "supply curve" for electricity growth, in the years since the 1984 Lovins' forecast, electricity use has grown 40%. The market's appetite for electricity grew enough to require the additional output of 350 power plants, each in the $500 million scale. As for the Union of Concerned Scientists' 1980 forecast for flat growth in electric demand, actual demand soared 70% from the date of their assertion.

The record, as reflected in myriad reports, articles, and studies makes it clear that the bold energy forecasts cited above were typical of those put forward two decades ago when the last energy debate was in full swing. These forecasts were part of a pervasive culture of energy prognostication that led to the implementation of billions of dollars in federal and state research, development, tax incentives, and regulatory programs to ensure that adequate "alternative" energy sources would be available. What followed in the two decades since these forecasts and programs was a 75% rise in the GDP made possible by traditional fossil fuels that supplied 65% of all net new energy, with nuclear power accounting for virtually all of the balance.

Without apology, and perhaps in part because of the absence of any mechanism for accountability, the same old crowd is at it again. Environmentalists and self-anointed

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energy experts were wrong twenty years ago. What credibility do such organizations and individuals have in making similar, often identical, energy technology forecasts today? Based on the record, the answer should be—none. The reason for the past and current failure of environmental energy forecasters can be found in their inability or unwillingness to understand technology progress in general and, more broadly, a paucity of imagination combined with a deep inherent pessimism regarding the technology innovations of industry.

If energy technology forecasting were a mutual fund established twenty years ago, it would have been bankrupt long ago and abandoned, rendered impotent by the power of market forces. But because energy forecasts directed at influencing federal and state policies entail the use of taxpayers' money, there is no "natural" market force for accountability. Clearly, being politically correct in energy forecasts means never having to say you're sorry, even if you are wrong. We imperil the nation's economic and energy future by ignoring the lessons of history, and basing policy on energy and economic forecasts made today by the same community of "experts" offering the same flawed nostrums as twenty years ago.

Introduction

The U.S. and the world's economies are inextricably anchored in the use of abundant and low-cost fossil fuels. Today the economies of the world use the energy equivalent of 60 billion barrels of oil a year. Fossil fuels supply almost 90% of all of that energy; oil alone supplies 25 billion barrels of the world's energy. And fossil fuels have provided 86% of the growth in energy supply over the past two decades. All this occurred as the average cost of fossil fuels collapsed over 40% from the brief peaks reached following the ill-advised OPEC oil embargo of 1973.

The reality of the magnitude and importance of fossil fuels appears to annoy environmentalists at some fundamental level. Two decades ago every environmental organization confidently forecast the end of the age of fossil fuels due to fundamental geophysical limits in supply. These limits were indicative, they said, of a transition to a permanent era characterized by "limits to growth" of all kinds.[1]

Instead of economic chaos inspired by energy shortages and soaring prices necessitating government intervention and rapid conversion to the ostensible nirvana of a renewable energy-based economy, the world's economies kept expanding, fueled by abundant, low-cost conventional fuels. Oil reserves, far from declining, expanded to record levels even as consumption rose and prices collapsed. Global "proved" oil reserves in 1997 reached nearly 1,200 billion barrels; the finding cost for oil has dropped from an average of $4/bbl to about 50¢/bbl in the last four years alone.[2]

Mandated and heavily subsidized alternative and renewable energy programs, as well as conservation initiatives, fell out of favor in an environment of low prices and resource abundance.[3] Then came the popularization of the theory of human-induced global warming. This theory, anchored in the core assertion that carbon dioxide emissions from the use of carbon-based fuels (fossil fuels) threaten the planet's atmosphere, provides the basis for environmentalists' efforts to resuscitate the entire panoply of energy prescriptions and programs that have served as their raison d'etre.

Carbon and Energy: Chemistry 101

This is not the place to delve into the fatal flaws in the theories of catastrophic human-induced global warming.[4] However, a little background is essential since the proposed restructuring of our entire energy infrastructure and economy is based on fear of carbon dioxide, CO_2, the primary gas implicated in the theories of catastrophic global warming.[5]

As all middle-school students learn (or are supposed to learn), CO_2 is one of the minor natural constituents of the Earth's atmosphere. CO_2 is partially responsible for keeping the surface of the earth warm by trapping the Sun's heat in phenomenon that was long-ago loosely termed the greenhouse effect—without which there would be no life on earth.[6] There are some additional important facts. The concentration of CO_2 in the atmosphere has been increasing for at least five decades (although, in terms of geophysical history, the time period of our direct measurements is a mere blink). It has been theorized that this increase in CO_2 concentration, measured in hundreds of parts per million, could lead to a catastrophic increase in the greenhouse effect and thus create the potential for world-threatening higher global average temperatures sometime in the next several decades or century.[7] Because the increase in CO_2 concentration is more or less coincident with global industrialization, and since carbon-based fuels are the primary source of civilization's energy, the theory is posited that human beings are: a) responsible for increasing global atmospheric CO_2 levels and thus, b) will be responsible for cataclysmic increases in future temperatures. This convenient coincidence[8] has resuscitated the fervor of environmentalists for renewable energy sources.

It is critical to note that CO_2 is not a pollutant, although environmentalists, and now the U.S. Environmental Protection Agency (EPA), are attempting to label it so through vigorous assertion.[9] Indeed, far from being a pollutant, *i.e.* an unintended by-product, carbon dioxide is the intentional product of activities needed to obtain energy, which is to say the oxidation (burning) of carbon to produce energy plus carbon dioxide.[10] A simplified "chem 101" formula looks like:

$$C + O_2 \rightarrow \text{energy} + CO_2.$$

Climate Insurance: You're In Good Hands?

Oil, natural gas, and coal are all carbon-based natural resources. It is precisely because carbon fuels are so pervasive and so important to civilization that schemes to reduce or replace fossil fuels have such significance. Schemes to "meaningfully" reduce CO_2 emissions require reductions of 50% or more in the use of fossil fuels. The only way that environmentalists can justify the draconian measures required to meet such a target is to posit a consequence of enormous global scope, to wit, catastrophic global warming. But there is a problem with this approach. If, after all, global warming presents a problem so daunting that solutions seem fruitless, and if the problem is so far off in time that the risks from fuel combustion seem too theoretical, then environmentalists are left with little of sufficient immediacy to demand such massive federal (and international) intervention on behalf of non-fossil fuels.[11] The core strategy proposal is that the U.S. government is obligated to begin immediately the transition to a low or zero carbon fuel

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future as an "insurance policy" precisely because the task is so daunting, and because by beginning now we might have time to avert calamity. The essence of this climate insurance policy strategy then is anchored in two premises:

> —The stakes are too high to take a chance. What if human-induced global warming *is* real, the argument goes, the consequences are so serious that action by government and industry is needed now. Waiting makes the shift to new lower-carbon technologies more difficult and more expensive. Typical of this rhetoric is: "The longer we wait, the greater the accumulation of fossil-fuel-dependent capital stock, and the more disruptive and costly future greenhouse reductions will be."[12]

> —We've got nothing to lose by starting the shift to renewable, non-fossil, and more efficient end-use energy technologies because looming shortages of conventional resources requires us to shift away from fossil fuel-based energy. This notion has provided the basis for environmental energy technology nostrums for decades. (It has served as the basis for Malthusian forecasts for two centuries.)[13]

According to global warming's true believers, we cannot delay. The United States must, they assert, abandon its "addiction" to carbon-based fuels soon anyway; and, leading environmentalists like Bill McKibben argue that we live in a "special moment in history" calling for bold government action.[14] This "special moment" is said to be created by our "understanding" of the emerging danger of catastrophic global climate change.

The technology insurance policy argument presents policymakers with a more comfortable motive, and moves the discussion from the arcane realm of global climate science to the gritty arena of government funding for energy technology programs. Alternative energy technology programs are viscerally appealing. Who can deny the appeal of solar power? Rationales for federal funding are anchored in the notion that we are going to need practical renewable energy technologies eventually, maybe even soon, regardless of the outcome of the climate science debate. The goal for advocates here is to attempt to obviate any debate over the scientific validity of the theory of global warming.[15]

The Role of Forecasting

Thus, central to the energy technology insurance policy argument, and to the core of all global warming forecasts, is the credibility of energy technology forecasts in general. Forecasting skills are required in all aspects of energy in our society. One must forecast with accuracy the technologies that will determine how much energy can be found, extracted, transported, and converted into useful forms. Additionally, one must forecast with reasonable accuracy how future technologies will impact the way in which energy will be used to make clothes, grow food, move people, manufacture cars and computers, ad infinitum. Because of the pervasive role of energy in society then, at the heart of all energy forecasts are presumptions regarding future technologies of all kinds.

The technology forecasts of global warmers and alternative energy advocates encompass two time frames: twenty years and 50 to 100 years. The twenty-year time periods for forecasting are essential for motivating policymakers to allocate funds. This is the traditional time period used by virtually all forecasters in the energy business, including the authors of the annually released Energy Information Administration forecasts. The 50-to-100-year time period is required by the nature of global-warming theory—it is the time period during which the truly catastrophic consequences are forecast to occur, a time period in which we in this generation are said to face a "special" obligation to our descendants.

Global warming adherents and alternative energy advocates appear by all counts confident in their technology forecasts, at least confident enough to encourage the profligate use of taxpayer funds for new energy programs. But do energy technology forecasts have any credibility? Who, twenty years ago, anticipated the energy requirements of PCs (their share of electrical use in commercial buildings is almost equal to the lighting load), or the energy and material needs for PC manufacturing? When it comes to 50-to-100-year forecasts, who in 1898 could have forecast the energy, infrastructure, and economic (not to mention social) implications of cars and aircraft? Forecasts from the recent, and not so recent, past actually provide a way to assess the credibility and accuracy of today's energy forecasts. In addition, the energy forecasts of twenty years ago were made by many of the same organizations and some by the very same people still active in advocating that economic life be adjusted to accommodate their vision of the future.

The Stakes

Environmental organizations and alternative energy advocates in the Administration are vigorously pursuing an agenda to ensure that federal and state energy policies embrace radical changes in the energy supply system of the nation.[16] Even the prestigious national federal laboratories, at the invitation of the Administration, have weighed in with a multi-laboratory assessment of accelerating renewable energy, to mitigate carbon emissions from fossil fuels, of course.[17]

The economic costs of a wholesale federal funding of alternative energy technologies penetrates far deeper into the economy than the mere squandering of taxpayers' dollars.[18] It is not enough to fund programs to "advance" alternative energy; environmentalists want requirements and incentives to accelerate the market's use of the new technologies, not the least of which is the oxymoronic goal to establish mandated shares of electric supply from renewable energy as a keystone in the "competitive" restructuring of the electric industry.

Encouraging or requiring the use of different energy technologies (selected by government fiat) will impact capital markets, since funds will be needed to replace otherwise perfectly useful existing technologies that provide and use energy. This misdirection of funds not only represents a lost economic opportunity associated with capital (a truly limited resource) that could have been used productively elsewhere (say, to improve profits), but the technology/equipment that is being displaced also represents a loss to the economy in the form of the abandoned residual capital value. At stake are literally trillions of dollars in net present-value capital assets in today's energy infrastructure. The economic fallout resulting from ideologically driven and ham-handed tampering with future technology choices is potentially stag-

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gering. Alternative energy advocates have not quantified these costs, nor are they likely to. Opponents of policy proposals based on global warming point to studies showing job and gross domestic product (GDP) shrinkage from higher energy prices. As serious as the economic penalties from higher prices may be, this could be the least of the damage.

Dismal Failure: The Energy Technology Forecasting Record

"In the future, scientists will learn how to convert stupidity into clean fuel."

Scott Adams, Prediction #16, *The Dilbert Future*, 1997

The basis for the assessment of the energy technology forecasting record of environmentalists, complicit organizations, and individuals is an archival collection of hundreds of studies, reports, books, and articles issued during the energy crises epoch of about two decades ago.

In the 1970s and early 1980s, there were four core mantras for environmentalists, self-anointed energy prognosticators, and apocalyptics: 1) all energy prices would soar; 2) oil resources would soon disappear; 3) renewable energy technologies were on the verge of becoming viable and cost-effective; and 4) electricity consumption would not, and could not, be permitted to rise.

All four of the core tenets were wrong and were shown by the passage of time to be wrong for fundamental reasons relating to the progression of technology in a dynamic marketplace. Following are some representative citations from the studies and papers of that long-forgotten energy crisis era for each of the above four core areas. (A larger representative, but far from exhaustive, collection of forecasts is contained in the Appendix.)

Energy prices would soar

"Conservative estimates project a price of $80 a barrel [in 1985], even if peace is restored to the Persian Gulf and an uncertain stability maintained."

National Geographic, February 1981

The price of energy is the single-most-important metric reflecting the collective impact of fundamental technology and resource trends.[19] Forecasting price thus is based almost entirely on the ability to anticipate the entire range of technology factors relating to how energy resources are found, transported, converted, and used.

During the peak frenzy years of the energy crises, there were many, in fact probably thousands, of price forecasts for energy in general and oil in particular. Even the esteemed National Geographic Society weighed in on this issue. The energy crisis was such a hot issue that *National Geographic* magazine took the step of producing a special issue devoted exclusively to the energy crisis. This rare seminal special issue led with the following conclusion. Far from stepping out on a forecasting limb, the *Geographic's* introductory observation about future oil prices, a bellwether for all energy prices, was carefully researched and represented the widespread wisdom of the day. All official and expert projections of that era saw energy prices rising. When forecasters hedged by providing a range of possible future prices, even the low ends of their ranges were far higher than the prices we enjoy today. Typically, the projected range for energy prices made in 1975 for the year 1995 were (in terms of dollars per million BTUs of energy):[20]

- Coal was projected to reach $3 to $5
  - actual price today ~$1;
- Oil projected $6 to $11
  - actual price today ~$3;
- Natural gas projected $4 to $8
  - actual price today ~$2

For the record: the average price of fossil fuels is nearly 50% lower today than the peak prices experienced over the past two decades. Oil prices have difficulty sustaining the $20 per barrel level even during times of turmoil, such as the Gulf War; prices in 1998 hovered in the mid-teens. The $20 level is a mere fraction of the price forecast by experts and environmental alarmists in the 1970s. In inflation-adjusted terms, the $80 barrel would be over $160 in today's terms.

Well, so they were wrong about the energy crisis of two decades ago. The argument we are presented with today by environmentalists is that global warming is different and requires a new look at our energy future.

Oil resources would soon disappear

1974 "Countries with expanding industry, rapid population growth. . . will be hit especially hard by economic energy scarcities from now on."

World Energy Strategies, Amory Lovins, 1974

1979 "The energy future is bleak and is likely to grow bleaker in the decade ahead. We must rapidly adjust our economics to a condition of chronic stringency in traditional energy supplies."

James R. Schlesinger, first Secretary of Energy, speech to the National Press Club, Washington D.C., August 16, 1979, published in the Congressional Record 9/24/79.

1980 "It is now *abundantly clear* that the world has entered a period of chronic energy shortages that will continue until mankind has learned to harness energy from renewable sources [emphasis added]."

Union of Concerned Scientists, *1980 Energy Strategy*

1977 "The supply of oil will fail to meet increasing demand before the year 2000, most probably between 1985 and 1995, even if energy prices are 50% above current levels in real terms."

Massachusetts Institute of Technology International Workshop & Report 1977

1979 "The oil-based societies of the industrial world can not be sustained and cannot be replicated. The huge increases in oil prices since 1973 virtually guarantee that the Third World will never derive most of its energy from petroleum."

Worldwatch Institute, 1979

Nothing resembling the gloomy forecasts cited above happened. In what is clearly in retrospect an alarmist viewpoint, James Schlesinger, President Carter's Secretary of Energy, the first to occupy that new post, was in fact merely reflecting the collective energy and technology wisdom of the times. As is now well-known, the nation's economic expansion since 1979 is almost unprecedented in the twentieth century. So too has been the general economic expan-

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sion of the global economy. Secretary Schlesinger could be forgiven his pessimism in the context of the times. This was, after all, an era which spawned the Club of Rome's seminal study, "The Limits to Growth," and its progeny. These studies, all based on careful, thoughtful, intellectual analyses and computer models, saw the near future in the same terms as articulated by this nation's first Secretary of Energy.

Following OPEC's unwise short-lived price escalations of the 1970s, Americans experienced a period of energy abundance driven by normal market forces and profound improvements in technology which continue today. U.S. oil consumption continues today at about six billion barrels per year, and world oil consumption has risen by over 2.5 billion barrels per year. All technical and geological indicators point to a period of "chronic" low-cost conventional energy abundance for the foreseeable future. In fact, U.S. reserves of oil and natural gas are up and have increased by record amounts during the year when prices were at record *low* levels. Oil discoveries per exploratory well in 1997 were six times the rate of the early 1980s when oil prices peaked.[21] Following the oil embargo, the conventional wisdom was that U.S. reserves were doomed to plummet, and rapidly. Yet over the past twenty-five years, a cumulative total of 80 billion barrels has been pumped from U.S. oil wells, and another 24 billion found to add to reserves, yielding a total of 104 billion barrels of oil from domestic sources. The conventional wisdom in 1973 was that the United States had 33 billion barrels of proved oil reserves left, and that was it.

As for the world, not only are the planet's oil wells producing at record levels, but proven oil reserves are double what they were two decades ago.

Renewable energy technologies were on the verge of becoming viable and cost-effective

1979 "The Carter Administration's goal is to provide 20% of all energy 'from the Sun' before the year 2000."
"A Progress Report on Alternative Energy Sources," *Fortune*, Sept. 24, 1979

1979 "There is an 'inevitable transition toward an economy based on renewable energy sources."
"The Good News About Energy," President's Council on Environmental Quality, 1979

1980 "One clear solution emerges: an aggressive strategy emphasizing improvements in energy productivity and the implementation of a variety of attractive solar technologies that can lead us out of the morass and onto the road to a safe and sustainable energy future."
Energy Strategy, Union of Concerned Scientists, 1980

1979 "The range of energy possibilities grouped under the heading 'solar' could meet one-fifth of United States energy needs within two decades."
Energy Future, Energy Project of the Harvard Business School, D. Yergen, R. Stobaugh, 1979

1981 "The [energy] Plan will require massive investment in equipment and processes that use energy more efficiently and in solar energy processes over the next twenty years. The $675 billion [Federal] investment in energy efficiency required by the Plan over the next twenty years will end up saving our society at least $300 billion."
National Audubon Society's 1981 Energy Plan[22]

For the record, windmills and solar power—the sources environmentalists and the general public perceive as energy "from the Sun"—contribute to under 0.5% to the nation's energy.[23] The only thing that is "inevitable" about renewable energy sources is the inevitability that advocates will continue the same refrain.

These renewable prescriptions are echoed in today's exhaustive "peer-reviewed" studies of the nation's energy options that are proposed to reduce the use of carbon fuels in a global-warming constrained world. The problem is that there have not been any fundamental changes in science or technology relevant to solar energy and the standard panoply of alternatives to portend any more likelihood of such forecasts materializing in the next twenty years.

Electricity consumption would not, and could not, be permitted to rise

1984 "We see electricity demand ratcheting downward over the medium and long term. The long-run supply curve for electricity is as flat as the Kansas horizon."
Amory Lovins, interviewed in *Business Week*, July 23, 1984

1982 "In no industrial country can additional electricity be used cost-effectively because the 'electricity-specific' needs are already met by present capacity with a good deal left over."
Electrical Week Aug. 2, 1982, "Lovins charts soft path."

1980 "Because saturation levels for most major appliances are achieved, only minor increases in electricity consumption [will] occur."
Energy Strategy, Union of Concerned Scientists, 1980

1979 "Despite its much-touted abundance, coal will not become our major near-term solution to the energy problem."
Energy Future, Energy Project of the Harvard Business School, R. Stobaugh, D. Yergen, 1979

Coal did become our major energy source, supplying about 45% of all net growth in the U.S. energy supply following the publication of *Energy Future*, which was the most widely read book on energy of that era.[24] More importantly from the market perspective, coal supplied two-thirds of all the increased supply of electricity over the past two decades. Over 90% of the GDP is associated with non-transportation activities, wherein 99% of all electricity is consumed, and where total demand for electricity grew 70% over the past two decades.[25]

Environmentalists both hoped and believed that electricity demand could not continue to rise. Massive federal and state investments were made in "demand-side management" programs, and utilities everywhere were discouraged or prohibited from engaging in promotional practices. There were substantial improvements in electricity efficiency. Yet demand for electricity still soared by 70% since 1977, despite two decades of anti-marketing. The central reason for the increased demand, and the failed forecasts, came about because an explosion of new electric technologies and applications has taken place (and continues to this day).[26] The

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obvious example (cited earlier) relates to the emergence of an enormous electric demand from both the use of PCs and the associated industry to fabricate them. (Modern multi-billion dollar integrated circuit "fab" plants rival steel mills in scale and cost.) What future technologies will be comparable in scope to the PC? Is it realistic to assume there will be no significant new future technologies?

Patterns from Past Prognostications

The studies of two decades ago reveal more than the failure to predict the end of fossil fuels. Like today's studies on global warming, energy experts two decades ago presumed to know much about the geophysics of the Earth—although then they were concerned with what was below its surface, not above it. Clearly, those experts were wrong. (This is not to imply that the environmental community has abandoned the belief that fossil fuels are imminently running out, but it is a tough argument to sell in an era of collapsed oil prices.)

The other dominant picture that emerges when looking back at two decades of resource, price, and technology forecasts with respect to energy is the same as for technology forecasts in general. Experts of the day exhibited a rampant pessimism about technology's ability to resolve contemporary problems or crises, and made linear extrapolations of doom for the near future. This should sound familiar even to those who follow popular articles about global warming on the most superficial level.

The other dominant picture that emerges from the energy forecasts of two decades ago is that many of the responsible organizations are still in the same forecasting business today. And many, if not all, of the forecasts use similar alarmist language, similar rationales, analogous scenarios of impending doom, and then offer the same energy technology solutions peddled two decades ago. Today's forecasts are driven by global warming worries associated with using too many fossil fuels, while yesteryear's forecasts were driven by worries over the disappearance of fossil fuels. But the ostensible scientific certainty, the claimed "peer" consensus, and the technology nostrums are virtually identical.

They're At It Again

1996 "Based on a review of many studies of recoverable crude oil that have been published since the 1950s, it looks as though such a shortfall [in crude oil] is now within sight. As this time approaches, we can expect prices to rise—markedly and, most likely, permanently."

"As the peak in production approaches, prices will begin to rise and the United States will have to quickly shift to new energy sources to mitigate the impacts on its heavily oil-dependent economy."

"Heading Off the Permanent Oil Crisis," James MacKenzie, World Resources Institute, *Issues in Science & Technology*, Summer 1996

1990 "We are, however, running out of the cheap oil and natural gas that powered much of the growth of industrialized societies."

"Energy in Transition," J. Holdren, *Scientific American*, September 1990

1998 "Global production of oil from conventional sources [of oil] is likely to peak and decline permanently during the next decade."

"Preventing the Next Oil Crunch," *Scientific American*, editorial introduction, March 1998

The fact that history and technology have trashed the idea of energy scarcity and rising energy prices does not mean that environmentalists have abandoned faith in this central Malthusian tenet.[27] It continues to be useful to promulgate the idea that fossil fuels will inevitably run out in order to support policies that encourage a shift away from them. The idea is simple. Since they're going to disappear eventually anyway, maybe soon, it is a good thing to start the shift now. And if that shift away from fossil energy is made more urgent by global warming fears, environmentalists can use this "fact" to power arguments for their alternative energy policies. The logic conveniently ignores the fact that if oil prices rise high enough, and stay there, private investment will rapidly shift to alternative energy sources, thereby obviating the need for government intervention (save perhaps to reduce the cost of capital).

The conviction that oil must get expensive, and maybe soon, is tough to abandon for environmentalists and special interests associated with alternative energy sources. Laying the groundwork for finding a Federal government alternative energy program, two senior appointees of the U.S. Department of Energy wrote a feature article in the April 1996 *Atlantic Monthly* magazine, entitled "Mideast Oil Forever?" providing a litany of quotes from today's energy experts, all opining once more that oil is about to become scarce and permanently expensive.

While twenty years ago the proposed radical changes in the energy infrastructure were motivated by the forecast disappearance of fossil fuels, this time the urgent admonitions are motivated by claims that our continued dependence on (now abundant but soon-to-disappear anyway) fossil fuels endangers the planet's climate. The similarities between the alternative energy proposals engendered by the oil crises of the 1970s and the proposals of today are very striking, despite two-plus decades of technology and industrial transformations.

The Actual (Instead of Forecast) Energy Record

For those who have forgotten, oil availability was accelerated by the removal of oil price controls, and natural gas resources ballooned with the abandonment of the misguided Fuel Use Act (prohibiting the use of natural gas for electric generation), along with relaxation of federal restrictions (and related federal revenues from auctions) on off-shore leases, especially in the Gulf of Mexico. And now the mere prospect of deregulation in electricity is causing a virtual collapse in the wholesale price of a kilowatt-hour—56% of which comes from abundant low-cost coal resources. The combination of the movement of government out of the energy business, and the general improvement in the climate for capital formation, along with the acceleration of new technologies, have all brought the United States to a situation that no environmentalist in their worst nightmare could have imagined; to wit, compared to twenty years ago:

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- Overall U.S. energy efficiency is 30% better, but. . .
- Total U.S. energy use rose the equivalent of 2.5 billion barrels of oil per year.
- Growth in energy continues to be biased to electricity with 85% of *all* new energy supply for the economy (excl. transportation) used to make kilowatt-hours. (See Figure 1.)
- Coal supplied nearly two-thirds of all new electric energy supply. (See Figure 2.)
- The deregulation of natural gas markets has recently accelerated a roaring return for gas-fired electricity, with over half of new kWh supply to 2020 forecast to come from gas (with still almost 40% forecast to come from coal).
- The U.S. GDP soared 70% in real terms, but total *spending on* all energy remained flat despite rising energy use and, in particular, despite 70% growth in electricity use, ostensibly the most expensive form of energy available. (See Figure 3.)

Forecast: "The long-run supply curve for electricity is as flat as the Kansas horizon." Amory Lovins, interviewed in *Business Week*, July 23, 1984.

Reality: The net effect of new technologies and of an expanding economy has been increased use of electric technologies, otherwise the relationship in Figure 1 would not have occurred.

Forecast: "Despite its much-touted abundance, coal will not become our major near-term solution to the energy problem." *Energy Future*, Report of the Energy Project of the Harvard Business School, 1979.

Reality: Fossil fuels, almost all coal, supplied the lion's share of new electricity. Without nuclear production for the next two decades, natural gas will need to grow 550%, while coal will still supply over 50% of supply in 2020.

Forecast: "The energy future is bleak and is likely to grow bleaker in the decade ahead. We must rapidly adjust our economics to a condition of chronic stringency in traditional energy supplies." James R. Schlesinger, Secretary of Energy, National Press Club, Washington D.C., 8/16/79.

Reality: The U.S. economy grew by $3 trillion, but total spending on all forms of energy remained flat at about $500 billion. The alternative? Allow or encourage energy prices to rise and direct income away from investment to paying higher energy bills?

Forecasts of Wishful Thinking? The Lessons from the Record

"Successful technologies are pulled along by the needs of the buyers, not pushed along by the ideology of the sellers."

Freeman Dyson, Professor Emeritus, Institute for Advanced Studies, Princeton[28]

What overall lessons about technology and energy technology can one derive from looking back at these energy forecasts of twenty years ago?

First, Malthusian pessimism pervaded every forecast, and continues today.

Every environmental or anti-fossil fuel organization eagerly embraced the notion of a permanent energy and oil shortage, permanent and rising oil prices, and a claimed vital need to shift to renewables. They were all wrong. Importantly, they were wrong because they gave short shrift to the power of advancing technology in general.

They were also wrong because experts in their own fields (renewable energy) imagined that technology would advance only for their favored devices, but not for anything else. Thus, while waxing enthusiastic about the potential for technology to lower the costs of windmills, solar cells, wave power, geothermal plants, biomass, even wood stoves and space power, they completely missed the possibility that technology would also advance in the fields of fossil fuel exploration, extraction, and utilization, thus lowering costs there too—and as it happened much more rapidly than for renewables.

Energy experts then did not foresee the advances in super computers and geophysics that have allowed accurate long-range exploration; the advances in materials science and engineering that have permitted unprecedented construction of multi-billion-dollar oil platforms in waters over a mile deep; advances in robotics which have permitted operations in hostile and deepwater environments; advances in materials and combustion technology creating ever more efficient conventional power plants, both small (cars) and large (power plants); advances in mechanical engineering and controls which have permitted safer and low-cost extraction of coal, and on and on.

Second, technological myopia, even blindness, infects energy forecasters.

Reading the twenty-year-old energy forecasts, and those of today, one sees that little has changed in the language, style, and nature of scientific argument. Then it was relating to the validity of catastrophic oil shortages. Today, it is apocalyptic global warming. The common denominator between these two global issues is how little we still know about planetary-level issues of geophysics. The second common denominator is found in the almost universal hysteria in language; then, about the certainty of oil's demise, today, about planetary warming.

The energy forecasters of the 1970s and early 1980s employed powerful computer models and phalanxes of experts to develop mechanisms to peer into the future. Today's fore-

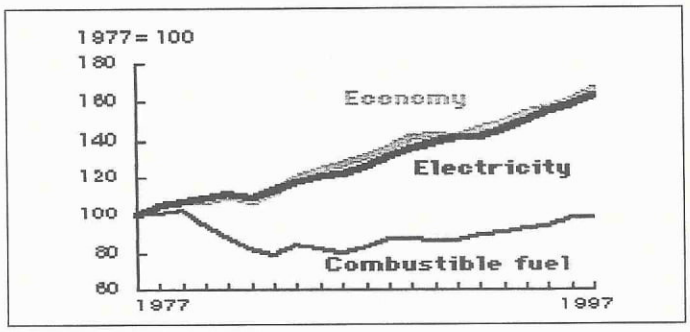

Figure 1. Electricity and coal in the Information Age (data excludes transportation). Data from DOE Energy Information Administration.

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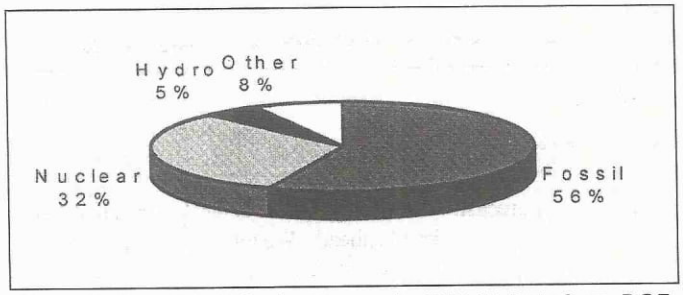

Figure 2. Growth in U.S. electric supply, 1977-97. Data from DOE Energy Information Administration.

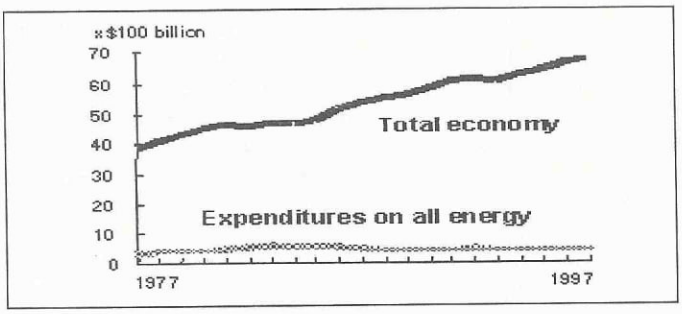

Figure 3. GDP growth vs. total energy expenditures. Data from DOE Energy Information Administration.

casters are using computer models and peer reviews too. The computers are more powerful today, but it cannot be argued that the crystal ball is any clearer. The single most important factor needed to make forecasts, regardless of the speed of the microprocessor, is an input that cannot be included in computer models because it cannot be quantified. This is the future technology factor. Forecasters have not only failed to anticipate specific technologies, but have also failed to anticipate the general direction and shape of technology trends in the energy industry. For some inscrutable reason, energy forecasting seems to be infected with its own special myopia.[29]

Third, environmentalists did not, and still do not, understand the forces driving electrification.

Environmentalists then (and still today) failed to anticipate the continuing, productive electrification of the U.S. economy. They believed that electricity use would level off because of a saturation in the market's use of any devices or processes dependent on electricity; simplistically, once 95% of homes had refrigerators and lights, and factories had all the motors they needed, future demand would remain flat even with economic growth because of steady improvements in electricity efficiency. They also believed that any increased use should be discouraged because rising electric demand would cause decreasing societal energy efficiency. Both of these views, still widely held, have been discredited by history. Overall national energy efficiency improved even as, and, in fact, largely because, demand for electricity rose about 70% with comparable growth in the economy over the past two decades. To be sure, electricity efficiency in existing applications (lighting, refrigeration, motors) improved dramatically. Excluding transportation data, where electricity still has little relevance, total societal energy efficiency is 35% better today than two decades ago, counting the fuels used in power plants. What environmentalists failed to anticipate was a continual flood of new technologies that use electricity, a trend that continues to this day, in every sector of the economy, and the fact that these new technologies are so productive and efficient that their overall effect was to improve energy efficiency, even when the fuels used at power plants are taken into account.[30]

Fourth, environmentally motivated energy forecasts are based on ideology and driven by wishful thinking. (In the parlance of the technology transfer world, this is called technology push, rather than market pull.)

This *fourth* lesson that emerges is that environmentalists today, just like energy experts and environmentalists of two decades ago, are simply too vested in their own ideological agenda (alternative energy and global warming) to see the big picture, or to understand the complex interactions of demographics, industry, the economy at large, and technology in general. They are driven, as Freeman Dyson succinctly notes in the citation at the top of this section, by their own "needs." Despite recent adoption of language meant to evoke a reliance on "market forces," environmental energy proposals are all still rooted in prescriptive designs for constraining energy choices in our enormous and dynamic economy.

Global Warming's Long Reach: 100-Year Forecasts

1886 "I take this opportunity to express my opinion in the strongest terms, that the amazing exhibition of oil which has characterized the last twenty, and will probably characterize the next ten or twenty years, is nevertheless, not only geologically but historically, a temporary and vanishing phenomenon—one which young men will live to see come to its natural end."

Professor J. P. Lesley,
State Geologist of Pennsylvania, 1886[31]

1893 "All the forests will be gone [by 1993]. Lumber will be so scarce that stone, iron, brick, slag, etc., will be largely used in the construction of houses. As a result, fires will be almost unheard of, and insurance companies will go out of business."

John Habberton, popular writer of the 1890s[32]

"Three hours will constitute a long day's work."
John Carty, electrical engineer, corporate organizer

"The occult sixth sense will be the predominant element in medicine and theology. Mesmerism will take the place of anesthetics in surgery. . .The pneumatic tube will be the means of transporting goods."

Ella Wheeler Wilcox, popular poet

"I presume that a speed from 90 to 100 miles an hour could be secured with modern locomotives and with the improvements which are sure to come. . .Electricity as a motive power for passenger traffic will be used much."

George Westinghouse

". . .the principle of the paddle wheel will remain supreme."
Alfred Van Santvoord, successful freight businessman

"The farmer may plow his fields and beat his dwelling with a storage battery no bigger than a common brick, the coal monopoly will be as dead as Julius Caesar."

J. H. Beadle, journalist, author, attorney

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"Aerial navigation for special travel or exploration. . . not largely universal or commercial."

Walter Wellman, adventurer, journalist

"Railway formed between Buenos Aires and Chicago."

William Eleroy Curtis, journalist, traveler, internationalist

At the core, energy forecasting is fundamentally anchored in technology forecasting in general. Herein lies the central problem, because of the dismal record of technology forecasting. Not only is it important to understand the kinds of technologies which will be available to find oil, or make and deliver electricity, it is equally important to anticipate the technologies that will emerge which determine how much, and what kind of, energy society needs. If one really believed that a revolutionary battery were imminently practical, the nature of automobiles and their energy needs could indeed change.

It would seem ludicrous on the face of it to expect governments to institute programs today that are directed at addressing technology needs for our descendants one century from now. However, in the context of what is implicitly and explicitly part of the global warming community's goals and nostrums, we are being asked to spend taxpayer dollars today to fund government programs that inherently assume much about how technology will progress over the next 100 years. If global warming were to happen as its advocates believe, we are told that in 50 to 100 years the consequences will come into full effect. By definition, that future society will use the technologies then available to meet needs and manage whatever problems exist then. Is there any reason to believe that anyone can usefully forecast specific technologies for 100-year time-frames? The corollary then: Is it reasonable to undertake any kinds of programs today based on such preposterously long-range forecasts?

Only a modest knowledge of history would suggest the answers. The folly associated with current long-term forecasts is most easily demonstrated again by considering past predictions, but this time for the longer time frame of 100 years.

Textbooks in oil geology go back a century and are replete with regular forecasts of the imminent disappearance of cheap oil. A broader view of century-long technology forecasts, not just energy forecasts (there was no such discipline a century ago) is conveniently available in a book republished a few years ago: *Today Then: 1993 as Predicted in 1893*. A few representative examples of the forecasts are listed at the top of this section.

The book contains a set of 74 essays originally published for the 1893 Chicago World's Fair. That event took place at a time when the economic and technological effects of the first industrial revolution were in full swing, epitomized by an entirely new class of mega-business, the railways. Also in place in the year 1893 was the realization of great impending changes as existing and emerging technologies advanced. Telephony and electricity, and the technologies associated with them, were exciting the imagination of people across the country.

Today Then was produced by the Newspaper Guild of 1893 when they commissioned essays from leading thinkers, great industrialists (including Westinghouse and Vanderbilt), as well as government officials, popular writers, and orators. Each was asked to describe the changes that they imagined would take place in America by the time 100 years had passed and the year 1993 arrived. The resulting collection of essays provides insight into the social, intellectual, and cultural biases of the day—all of which unavoidably affect thinking about the future. For perspective, many of the forecasters who wrote for *Today Then* were Civil War veterans.

Perhaps the most remarkable feature of this collection of nineteenth century visionaries is that they actually were more successful than energy forecasters of just two decades ago. Unlike these agenda-driven forecasters, the sages of 1893 actually had a surprising number of "hits." And while the hits were in a distinct minority, the prescience was remarkable.

"On account of fast and cheap travel, cities will become groups of suburbs."

David Swing, minister, journalist

". . . millions of dwelling houses will be artificially cooled in summer, as they are now heated in winter."

Felix Oswald, world traveler and writer with international readership

"Electrical research and experiment will lead to an industrial revolution."

Charles Foster, banking and petroleum industry

More typical of those who got it right (and these too were in a minority) were the few forecasters who painted the future with a very broad brush. Their visions were stated in grand terms based on their belief in the power of ongoing technology progress:

"It is useless to attempt to foretell the improvements in mechanics, in industrial arts and in modes of travel as it would have been forty years ago for any one to have anticipated the telephone and its now universal use."

Hempstead Washburne, Mayor, attorney, banking businessman

"The multiplicity of inventions, the variety of modes, and the expertness in application have wonderfully increased the efficiency of labor, diminished the cost of production and added much to the comforts of men."

W.A. Peffer, educator, attorney, senator, wrote influential farm journal

"The commercial development of the United States in the twentieth century will be prodigious."

Matthew Borden, Director of Manhattan Bank

"There is no apparent limit, except the limit of the world itself, to the growth of wealth, to the augmentation of opportunity, and to the achievements of this American people."

Erastus Wiman, printer, reporter, editor

However, despite glimmers of forecasting brilliance, there were few exceptions to the basic rule: century-long technology forecasts were fatally flawed. Those that got something correct did so, as previously noted, when they were general; ". . . houses will be artificially cooled." The forecaster didn't say on what technology the cooling technique would be based, but rather simply expressed the view that science and engineering could accomplish this needed task. The confidence, and accuracy, in these kinds of forecasts arose from a combination of a sense of opti-

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mism for technology progress, and critically, a recognition that newly emerging scientific discoveries and technologies would surely make such things possible. At the time of the forecasts explored here, it was the dawn of the electric and automobile age—truly revolutionary changes in basic infrastructure technologies available to civilization. (The forecasts pre-dated the Wright brothers first powered flight by ten years.) Many of the 1893 forecasters recognized the impending revolution, and envisioned substantial, but broad, changes because of it.

> "Steam and other sorts of power displaced by electricity."
> Charles Foster, involved in banking and petroleum industries

> "The use of electricity serving the household exactly as gas, steam and coal now serve it."
> John Carty, electrical engineer, corporate organizer

> "Electricity will be the supreme power. . . Domestic life and avocations will be rendered easier, less costly, and less complete by the distribution of light, heat and energy through storage cells or from central electric stations."
> John Ingalls, attorney, orator, writer

> "Electricity providing power and light for cities as far as New York and Philadelphia on the east, and Cleveland, Cincinnati, and Toledo on the west."
> Albert Shaw, New York Assembly, diplomat, President of the Canadian Niagara Power Company

The salient difference with environmental forecasters today is that they are not (or perhaps cannot be) optimistic about comparable fundamental technology changes now underway, and thus cannot imagine or consider the scope of broad changes and new services, products, devices, and benefits society is yet to gain from emerging technologies today. While even the more prescient visionaries of 1893 did not come close to anticipating the true and astounding scope of change that came to America over the subsequent century, they at least recognized that such change was not only possible but inevitable. Today's putative energy forecasters neither recognize, nor acknowledge, that comparable, or greater changes, are still likely over the time periods they use in their analyses. This is ironic considering that more technology change has occurred during our living memory than in that of the 1893 forecasters. Surely this would create a basis for understanding that more, and substantial, technology is not only possible but inevitable.

Time-lines and Trajectories for Technology

In 1893, the forecasters examined here were excited about the potentials of electric technologies. At that point in history, it had been nearly sixty years since the technology of the electric generator had been invented in 1832, but only eleven years after the famous Edison Pearl Street central electric generating station went into operation. The telephone was a somewhat more recent phenomenon for them; it been invented two decades earlier (1876) with long-distance phone service inaugurated between New York and Boston in 1884.

What one sees from these timeframes is that the forecasters in 1893 were only just beginning to experience the technological and economic acceleration of critical, new basic inventions and engineering capabilities, despite the fact that the core concept may have been known to them for twenty more years (the telephone) years and sometimes sixty years (the electric generator). One sees in this time lag the evolution of a new technology from concept to practicality. The emergence of the concept alerts people only to the general potential; historic analogies show a common twenty-year-or-so time lag from idea to emergent, engineering potential.[33] Full penetration into society of a fundamental technology change took longer than two decades. Such changes created structural and economic impacts on the nation's infrastructure that took decades to be fully realized, and were generally unpredictable in their scope, nature, and collateral effects. To be sure, very rapid and visible technological changes did take place in the twenty-year periods. Consider that the nineteenth century information revolution of telephony went from invention to practical long-distance service in less than twenty years. But the scope and depth of the impact of telephony on society and industry was not clear to anyone in those first twenty years, nor even during the subsequent two decades.

At the time of the 1893 forecasts, the transportation revolution had yet to be realized, but was on the kind of trajectory just outlined. The Wright brothers first powered flight took place in 1903. The two decades following the invention did not see the development of a commercial aviation industry, but aircraft did began to have their revolutionary impact in that two decade period, seen vividly during the First World War. It was, however, fifty years after the first powered flight that widespread civil aviation became a major industry and force in human affairs, epitomized perhaps by America putting a man on the moon only sixty-six years after Kitty Hawk. The shape of this trajectory of change is common in history and has much to imply about both short-term, twenty-year, and long-term, fifty plus year forecasting.

These timeframes are echoed in modern times. The integrated circuit was invented in 1958. By 1978, twenty years later, the power of the microprocessor seemed to be clear, creating new industrial giants such as IBM. But remember that it wasn't until 1973 that the first simple four-function calculators (the precursor of the PC) came on the market, priced at over $1,000 in 1998 currency. A fifteen-to-twenty-year time period did not reveal the real power of the microprocessor, nor did anyone in the 1970s correctly anticipate the magnitude and pervasiveness of the changes it would yet bring to industries and society.[34] The length of time it takes new technologies to overcome the institutional inertia in society's infrastructures suggests that the equivalent of the man-on-the-moon impact from integrated circuits is yet to be seen, and if the patterns hold is not likely to manifest itself until 2020 or so—some fifty to sixty years after the first invention. Without regard to what those impacts may be, they will surely have profound implications for the nature and magnitude of how energy is used. And it is certainly clear that global warming-inspired technology forecasts ignore such potentially profound change and progress.

History more than suggests, it virtually promises, overall technological changes of much greater magnitude than any envisioned by global warming advocates. And we do have adequate information to at least map the landscape

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of change. There is as a minimum the historic record of technological trajectories and time-from-inception-to-market for major technological changes. When all of the technological assumptions associated with global warming forecasts are viewed in the context of the historic record, they seem misguided, to put it mildly. The kinds of technology changes now underway will radically alter the nature of tools our children and grandchildren will have available. But the changes will not fully manifest themselves in the one or two decade time periods that are reasonable for us today to plan for and spend money on.

Environmentalists may assert, or even believe, that such alternative energy technologies as solar power and windmills are the equivalent of the first powered flight, or the first integrated circuit. They indeed have warned the conventional fuel industry of impending economic extinction should those companies fail to capitalize on the energy revolution environmentalists envision arising from their favored technologies. There is a central problem with the notion that alternative energy technology represents some kind of revolution-in-waiting. Windmills, solar power, indeed the entire panoply of favored alternatives, are not new or revolutionary inventions. They do not arise from newly discovered principles of science; neither are they based on, nor do they epitomize, fundamental changes in engineering capabilities. Indeed, most alternative energy technologies are more stone-age in character than high-tech: burning wood and trash, tapping hot springs, capturing running water and the wind. The most exotic of the alternatives, solar photovoltaics, is based on the scientific phenomenon whose discovery yielded Albert Einstein a Nobel Prize, and led to the first solar-electric cell being demonstrated in 1925. We have had more than ample time—seventy-five years—for this technology to follow long-standing commercialization trajectories were it going to do so.[35]

Patterns in Technology Forecasting

"In human affairs—political, social, economic or business—it is pointless to try to predict the future, let alone attempt to look ahead seventy-five years. But it is possible—and fruitful—to identify major events that have already happened, irrevocably, and that will have predictable effects in the next decade or two. It is possible, in other words, to identify and prepare for the future that has already happened."

Peter Drucker[36]

So what can one derive from the record of technology forecasting? Today there is a thriving private and academic business discipline associated with technology forecasting techniques. For analysts in 2020, there will be a rich body of material to make hindsight judgments about today's forecasters. The explosion in the professionalization of technology trend forecasting arises from a broad realization (at least outside of the environmental community) that technology is changing rapidly, and changing much about all businesses. However, the purview of most business forecasts remains, wisely, limited to rather short (often less than ten-year) timeframes. But today, because of the activities of global-warming advocates, the government has chosen to concern itself with technology policies that are being driven by forecasts encompassing twenty-year timeframes and beyond.

Some fairly clear lessons and threads of continuity emerge from the ideas contained in the previous tables and discussions regarding twenty-year and 100 year technology forecasts.

In the very long run (~100 years) no one really has a clue about what specific technological and associated social, economic, and institutional changes will occur.

A few prescient and lucky people will make correct guesses about a few general aspects of the future. The record suggests they are most likely not to be engaged in any aspect of the technology or industry about which they are prognosticating. Poets seem to be more likely to get it right than industry experts.

• *The most consistent problem with long-term (50 - 100 year) forecasts is that they underestimate the magnitude, nature, and pace of change.*

Over the long term, generational changes in businesses, institutions and physical equipment occur. In addition, there are fundamental changes in basic science (such as the discovery of electricity, the genetic code, etc.) that create whole new classes of technologies, often inherently unpredictable and frequently occurring for serendipitous reasons, thus defying government or any other directed research.

• *The most consistent problem with short-term (20 year) forecasts is that they frequently over-estimate the pace of change.*

In the short run, pundits tend to ignore the inertia inherent in organizations, human institutions, and something one might term "capital inertia," since existing investments in equipment have enormous market value in this "short" term. Also in the short term one must deal with the physical realities of how long it takes to design, build, and bring to market major infrastructure changes—even where the marketplace wants to use the new technologies.

• *Another consistent short-term forecasting error arises from a failure to differentiate between what is simply possible, and what is practical or useful.*

It is possible to build personal, Buck Rogers-style jet backpacks. They were first built in the late 1950s. They're commercially available today. They're just not useful. Windmills are the Buck Rogers equivalent in the alternative energy community. They're commercially available, they're just not generally useful.[37]

• *Those directly engaged in or profiting from a technology activity of the day are often the worst at anticipating the direction and nature of technology change in their area of expertise.*

The phrase "peer-reviewed" in technology forecasts is a danger signal (unlike in the fields of basic research, where it is a critical positive signal). "Peer-reviewed" when it comes to technology forecasts usually means that other people of similar limited vision and parochial interests have reviewed and added little of imaginative value to the topic in question. The experts of the day may be very good at the business of extracting value from a technology they are familiar with, but frequently myopic about emerging technologies that could capture their market niche.

On May 24, 1844, Samuel Morse successfully transmitted the first electric message from the U.S. Capitol building to Baltimore. Within a decade the United States had 23,000

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miles of telegraph wire, and within three decades the telegraph circled the world and revolutionized communications, government, and business. It was the kick-off for the communications revolution that continues today. But Morse himself thought the telegraph would only be useful to governments for sending important messages. In fact, he was so certain of its limited value that he tried to sell the rights to the federal government for $100,000. Even Alexander Graham Bell suffered from the same technological myopia. He too attempted to sell the rights to his invention, the telephone, about thirty years after Morse's similar attempt. Bell offered to sell his rights for $100,000 to the Western Union company. Amazingly, Western Union, which by that time was a major communications company, had no concept of the value of telephony and turned Bell down.[38]

Environmentalists today try to use this lesson for their own purposes by suggesting that energy companies run the same risk of not buying into windmills or photovoltaics. This is wrong-headed. Windmills and photovoltaics are neither new nor revolutionary, and offer no economic, operational, or practical advantages over competing technologies.

• *Generalities tend to yield more accuracy and insight than narrow technology-specific projections; forecasts of the direction and nature of change, as opposed to product-specific predictions, are more often winners.*
Westinghouse, in 1893, thought about travel in 1993 in terms of how fast trains might travel—which he egregiously underestimated in any case. Others, not involved in the rail industry of 1893, foresaw a future enhanced by far faster and different forms of travel, including aviation, despite the fact that the Wright brothers' first historic flight was at that time a decade away.

• *Technologies change, but human behavior does not.*
Technology forecasting that assumes implicitly or explicitly that human behavior will change in some fundamental way can be safely ignored. Little has changed in recorded history regarding the basics of human behavior and social interactions; even less has changed since the days of Shakespeare, whose observations about human behavior are so pointedly accurate that they have become clichés. The toys change but the people don't.

Peter Drucker is arguably one of the more insightful thinkers and generalists of our time. When it comes to forecasting, there are some useful observations that can be offered based on Drucker's advice to "identify major events that have already happened, irrevocably, and that will have predictable effects in the next decade or two. It is possible, in other words, to identify and prepare for the future that *has already happened.*"

When Drucker refers to what has "already happened," he frequently cites basic demographic and physical trends. The population is growing, becoming older, more affluent, etc. These trends have important predictive value. The fact that world trade is increasing, and telecommunications becoming cheaper are portents with predictive value. Increased affluence and accelerating technology will lead to rising use of the energy sources most tightly linked to economic growth; to wit, electricity. Increased global affluence will bring about not only rising electricity demand, but also rising oil use as more people can afford automobiles. There is no technical invention in place today that can meet the magnitude of energy demands for transportation and electricity *for the next two decades* other than those already existing.

Figure 4 illustrates that the relationship between average national electricity consumption and average national GDP is powerfully predictive. As national economies expand, demand for electricity will rise, as will demand for oil. No other reasonable conclusion can be reached in the twenty-year time periods for technology forecasting. Programs to discourage this trend can only be socially and economically damaging.

The End of Technology?

"Life in the future will not be like Star Trek."
Scott Adams, Prediction 47, *The Dilbert Future, 1997*

Science fiction writers, legislators, and the general public all believe that technology will advance. While it is unreasonable to believe that we can today accurately forecast the long tomorrow, it is reasonable to believe that it will be dramatically different and that technology will be a major driving force. But to believe what Malthusians believed and continue to believe, and more specifically, what energy Malthusians said, and continue to say, one has to believe that technology progress has basically stopped.

Malthusian believers continue to make forecasts about the purported condition of the economy and the fate of humanity for the next century despite 200 years of failure for their predictive methods.[39] Today's neo-Malthusians continue to prophesy impending gloom from depleted resources, rising prices, population explosion, famine, etc. No doubt many of us are fascinated by long-term forecasts of any kind. But much of what passes as forecasting on the part of environmentalists and Malthusians (generally one-and-the-same) reflects a profound lack of imagination and an inherent pessimism about the kinds of basic scientific and technological changes that are inevitable over the next century. Malthus' failure was, fundamentally, that the extrapolations he used in his famous essay of 1798 assumed that no new technologies or scientific knowledge would appear in the future. This is also the inherent failure in Malthusian thinking today.[40]

While environmental Malthusians exhibit endemic failure to foresee or believe in continued technology progress, to be fair even the best in the field of science fiction have only managed to anticipate accurately very narrow areas of

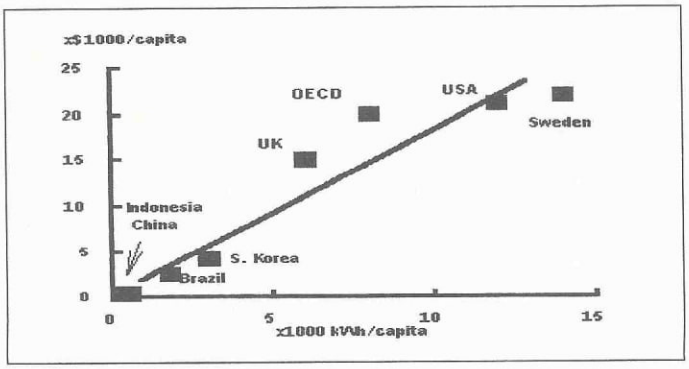

Figure 4. Data from OECD, EIA.

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technology change. The difference is that the science fiction writers believed that change would continue.

But how could forecasters, even in the guise of fiction writers, anticipate the technologies that would emerge from inventions that didn't exist in their day? Even fanciful extrapolations require some kind of basis. How could one forecast today's technologies before the vacuum tube was invented, not to mention the transistor and integrated circuit? A number of the most prescient forecasts made in 1893, while vague, at least recognized the impending changes from the emergent technologies of electricity generation and use. The early engineering forays into generating electricity provided the kernel of ideas for forecasters of 1893. But a few decades earlier, it would have been impossible to envision anything relating to the entire array of technologies using electricity because neither the basic scientific ideas nor the engineering tools even existed. Virtually all future technology possibilities changed in a fundamental way when James Clerk Maxwell, a Scottish mathematician and physicist, produced his crowning achievement which set the stage for the entire age of electricity between 1864 and 1873. Maxwell put into mathematical form a few simple, elegant, and profound equations that expressed all the varied phenomena of electricity and magnetism. Maxwell's equations provided the keys to a new technological era based on electricity.

Many brilliant scientists who preceded Maxwell provided much in the way of basic information and understanding that led up to Maxwell's equations, and many followed to elaborate and expand on his work. Nonetheless, his equations were the catalyst that in one century changed the world so profoundly as to defy anyone's imagination in the years prior to Maxwell's conception. Once scientists and engineers discover the rules that underlie certain basic forces, they soon develop the ability to use those rules to fabricate new and previously impossible products and devices.

Are comparable transformations in scientific understanding and engineering capabilities possible in the future, especially over the long timeframes often considered by global warming theorists? To assume not is to assume that there is nothing fundamental left to discover, a ludicrous notion.[41] And without considering fundamental technology changes, it is inconceivable that energy forecasts for the next two decades, much less half-century-plus, have any credibility. There are, of course, a variety of areas of basic science and technology where profound changes are clearly possible, wherein there are profound implications for resource and economic, not to mention social, institutional, and political systems.

The End of Technology, or Just the Beginning?

One of the remaining great mysteries in physics is gravitation. Einstein spent much of his life attempting to develop the basic rules of gravitation, the search for a unified theory. Scientists appear closer today, but the equivalent of Maxwell's keys have not been uncovered. One can only begin to imagine the implications of controlling gravity, which is a virtual inevitability once science produces the rules that engineers can use. Could this happen before a century passes? No one can possibly know for certain. But nothing in history suggests that this puzzle will not eventually yield to human inquiry. Indeed, current scientific progress and history suggest that this particular puzzle could be solved within a century. The world of 2098 could look quite different indeed. Control of gravity would change everything—literally. Certainly space travel becomes easy.

Similar impending changes, perhaps of lesser or greater magnitude, attend the emerging fields of biotechnology and nanotechnology. Freeman Dyson believes the twenty-first century will be the "century of biology."[42] Considering the prodigious medical implications of biotechnology, there are many others.

Already bioengineered organisms make it possible to extract, or clean up, oil more efficiently. It is likely that the natural resources of fossil fuels—of which the planet holds an astounding abundance in difficult-to-extract form (oil shales, tar sands, *etc.*)—could be tapped inexpensively with bioengineering assistance. There is already some suggestion that bioengineering organisms can be produced that will have the capacity to convert carbon dioxide emissions from combustion into useful (perhaps even economical) ethanol.

The field of nanotechnology holds the potential for changes that are already giving rise to new excursions of fancy in science fiction. The possibilities are tantalizing in ways that make it clear that the next 100 years promises changes as, or even more, dramatic as any of the past 100 years. Engineers have shown that they are capable, even with today's nascent technology, of fabricating microscopic motors and devices.

The field of mathematics will yield surprises yet. Today's computers, for example, owe their ability to function to the logic (software) ideas established by Von Neuman in the 1950s. Can scientists take us beyond today's software as developers seek to bring new functionality to computers? What future mathematician, perhaps only born last year, may provide in his or her lifetime a new mathematical framework as profoundly important as Von Neuman's, revolutionizing software and computational power? Any such development would be amplified by the continuing growth in basic microprocessor capabilities, one reinforcing the other to increase computational capabilities by orders of magnitude. Real thinking machines could emerge. Peter Drucker has written recently about the profound failure of computers, in effect their software, to improve the most important part of daily business and political life—decision-making.[43] A different approach to computing could bring electronic devices that can actually help decision making. What then?

The point of these cursory observations about fundamentally important, emerging changes in technology is that imagining our great grandchildren's world is as difficult for us as imagining how today's electric world would have been for people in the pre-Maxwell days of the early to mid-1800s. Many environmentalists today are doing the equivalent of worrying about finding better lamps to burn whale oil at the dawn of the age of electric lighting. Better to let science and technology flourish. Not only did electric lights replace whale oil lamps, electric lighting gave birth to entirely new uses for light which no one could have dreamed of a century ago. Lighting technology today is not only used for convenience, decoration, or advertising purposes, but also to process materials, cure paint, destroy pathogens in water, and even clean air. The most powerful of all lights—lasers—are used to weld, cut metals and fabrics, selectively catalyze

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chemical reactions, perform surgery, play music, and may even launch micro-rockets. Could the whalers of New England have foreseen these possibilities? Did even Thomas Edison forecast such specific technological derivatives from his work? Did forecasters twenty-five years ago?

Unless one presumes that the progress of science and technology has ended, that no significant new basic discoveries and technologies are possible, it is ridiculous to engage in plans to manage, anticipate, or direct technology over time periods beyond twenty years. Yet this is precisely what many in the expert community engaged in promoting the theory of global warming are attempting to do. We are being asked to put at risk trillions of dollars in investment in existing energy technologies on the basis of twenty and twenty-plus year technology forecasts that have no validity.

Table 1: Energy & Energy Technology Forecasts Made Circa 1979 for the Years 1990 to 2000

The industrial world was awash in studies, books, and reports on the energy problem from the mid-1970s to the mid-1980s. The market for such books and studies dried up as an energy crisis failed to materialize, and as the price of oil relaxed back to the level it has been at for more or less a century (in inflation-adjusted terms). The following is a very small sampling of predictions and claims from the energy studies, reports, and committees of that era. Despite the certainty, and often grandiose scope of many of the forecasts, they were all proven by the passage of a mere two decades to be wrong.

"Cheap oil and gas are running out."

Our Energy: Regaining Control, M. Ross, R. Williams, 1981.

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"The oil-based societies of the industrial world cannot be sustained and cannot be replicated. The huge increases in oil prices since 1973 virtually guarantee that the Third World will never derive most of its energy from petroleum."

"Solar Possibilities," Denis Hayes, Worldwatch Institute, *Energy Journal: Special Issue: Renewable Energy Prospects*, October 1979.

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"Although we hear much about various future sources of energy the work of our civilization is wedded to the fossil fuels—coal, oil, and natural gas—sources of energy that are dwindling rapidly."

Energy for Survival: The Alternative to Extinction, W. Clarke, Anchor/Doubleday Books, 1974.

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"It is now abundantly clear that the world has entered a period of chronic energy shortages that will continue until mankind has learned to harness energy from renewable sources."

Union of Concerned Scientists, *Energy Strategy*, 1980.

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"Despite its much-touted abundance, coal will not become our major near-term solution to the energy problem."

"The range of energy possibilities grouped under the heading 'solar' could meet one-fifth of U.S. energy needs within two decades. . .domestic oil and gas, coal, and nuclear power, as a group, can increase their contribution to cover, at most, one-third to one-half of the nation's additional energy needs over the next decade."

"In that case, new electric generating plants might even be permitted to use natural gas. This seems, on the available evidence, to be the least likely outcome, but it is possible."

"The essential point is that the nation should not plan on greater quantities of natural gas to stop the rise in oil imports. Indeed, it will be a challenge to find enough new gas reserves to maintain production at current levels."

"The only realistic two options for the short-term are wood and wood waste, and on-site solar technologies, such as solar heating, small hydropower, and small wind."

Energy Future, Report of the Energy Project of the Harvard Business School, Ed., Stobaugh, Yergen, 1979.

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"There are four conventional sources of domestic energy: oil, natural gas, coal, and nuclear power. But all four are likely to deliver less energy than projections by their advocates would lead one to believe."

"We must rapidly adjust our economics to a condition of chronic stringency in traditional energy supplies."

"In short, if we are effectively to grapple with our energy problems, we must accept an adjustment, indeed a decline, in our historic expectations. How will the American society respond to this revolution of declining expectations?"

Speech by James R. Schlesinger, first Secretary of the U.S. Department of Energy, September 24, 1979.

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"Countries with expanding industry, rapid population growth. . .will be hit especially hard by economic energy scarcities from now on."

World Energy Strategies, Amory Lovins, 1974.

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"The long-term prospects for selling more electricity are dismal. . . However, we see electricity demand ratcheting downward over the medium and long term."

"We would expect in the short term that a recovery would stimulate electricity demand to recover toward its previous levels. However, we see electricity demand ratcheting downward over the medium and long term."

"The long-run supply curve for electricity is as flat as the Kansas horizon. We will never get, we suspect, to a high enough price to justify building centralized thermal power plants again. That era is over."

"Far from there not being enough renewable sources to run an advanced industrial society, we will find there are too many. There won't be enough demand to support them all."

Business Week, July 23, 1984 interview with Amory Lovins, "Soft Path for Hard-pressed Utilities."

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"In sum, all of the energy sources currently being promoted as the backbone of American energy supplies into the twenty-first century are precisely those least-suited to surviving the uncertainty and violence that seem likely to characterize the future."

"The Fragility of Domestic Energy," Amory Lovins, *The Atlantic*, November 1983.

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"In no industrial country can additional electricity be used cost-effectively because the 'electricity-specific' needs are already met by present capacity with a good deal left over."

Electrical Week, August 2, 1982, "Lovins Charts Soft Path."

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"One clear solution emerges: an aggressive strategy emphasizing improvements in energy productivity and the implementation of a variety of solar technologies that can lead us out of the morass and onto the road to a safe and sustainable energy future."

"Because saturation levels for most major appliances are achieved, only minor increases in electricity consumption would occur."

Union of Concerned Scientists, *Energy Strategy*, 1980.

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"We now know future energy supply with much more accuracy than we know demand, or macro-economic growth."

"Energy Soothsayers Not Saying the Whole Sooth," P. Basile, *The Bulletin of the Atomic Scientists*, November 1980.

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"Achieving low-energy growth will not be easy or cheap, but it will be far easier and less costly than achieving high-energy growth. In an age increasingly beset by all kinds of limits (resource, environmental, and social), conserving energy through improving fuel productivity is the single most effective means of easing our long-term environmental and energy problems. And it provides an essential link in the inevitable transition toward an economy based on renewable energy sources."

"The Good News About Energy," Report of President Carter's Council on Environmental Quality, 1979.

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"The [energy] Plan will require massive investment in equipment and processes that use energy more efficiently and in solar energy processes over the next twenty years. . .The $675 billion [Federal] investment in energy efficiency required by the Plan over the next twenty years will end up saving our society at least $300 billion."

National Audubon Society's 1981 Energy Plan.

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"Indeed, we might feel obliged to restrict use of the new [synthetic] fossil fuels long before their supply ran out."

"If Americans can pay $2 for a gallon of milk, it is hard to see why such prices for energy would seem outlandish."

". . .the Carter Administration's pledge that the nation will be getting 20% of its energy from the Sun by the year 2000."

"A Progress Report on Alternative Energy Sources," *Fortune*, special report, September 24, 1979.

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"At the projected rates of consumption and discovery, the limited availability of discovered reserves could cause oil production growth to taper off and possibly reach a plateau before the end of the century."

"World Energy Outlook," Exxon Background Series, April 1978.

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"The main conclusion of a new study of the OECD's International Energy Agency [is that] from the late 1980s onward, oil supplies will not be able to keep up with the demand for oil."

"The Deceptive Glut," *OECD Observer*, November 1982.

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"The supply of oil will fail to meet increasing demand before the year 2000, most probably between 1985 and 1995, even if energy prices are 50% above current levels in real terms."

Energy: Global Prospects 1985 - 2000, Workshop on Alternative Energy Strategies, MIT, 1977.

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"Liquid and gaseous fossil fuels are relatively benign and until recently were both abundant and cheap. How will we cope with their increasingly limited availability and unreliable sources of supply? How well can we adjust to their higher prices?"

"Not too surprisingly, the first policy step is getting prices right, so that both consumers and producers of energy will treat it as the more precious stuff it has become."

"As to future energy supplies and costs, we find that there are serious short-run producibility problems for oil and gas."

"On average, nuclear energy was found to be cheaper than coal. . . for new power plants that could be constructed for operation in the mid-1980s."

"It appears that energy resources have been depleting faster than technology has been improving, so that the cost of energy has gone up recently relative to that of other goods and services."

Energy in America's Future: The Choices Before Us, Resources for the Future, 1979.

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"A chief problem facing the new administration in Washington is devising an energy strategy that encourages American economic growth while coming to grips with the international economic balances that are being so radically altered by the pressures of energy cost and social unrest."

"Conservative estimates project a price of $80 a barrel [in 1985], even if peace is restored to the Persian Gulf and an uncertain stability maintained."

"[Policies will require] adjusting to high and rising energy prices."

H. Landsberg, Resources for the Future, "Energy: A Special Report in the Public Interest," *National Geographic*, February 1981.

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"Instability in that region will almost certainly continue to increase in the years ahead, with interruptions to supplies more frequent, and oil prices increasing at rates that will pose an even greater threat to the stability to the world economy than today."

John F. O'Leary (former Secretary of Energy).

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"In short, because of high interest rates and uncertain returns on fuel-related capital investments, the market is not likely to make a timely response to dwindling supplies of oil and gas. The necessary incentives are just not there. To avert the problems that a delay would cause, then, some government pump priming is in order."

"If present trends continue, and there is every reason to believe they will, the quality of fuels available to the U.S. economy will deteriorate. Total energy consumption will stagnate."

Beyond Oil: The Threat to Food and Fuel in the Coming Decades, Gever *et al.*, Ballinger Press, 1986.

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"The generally rising real price of energy lends advantage to higher investments in both supply and conservation. . .As prices rise in the coming decades, more such opportunities will appear."

"Given the probability that world oil production will peak in the 1990s and decline gradually thereafter, it is thus extremely unlikely that the United States will be able to offset its declining domestic

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production of fluid fuels by increasing its share of world imports."

Energy in Transition 1985-2010,
National Academy of Sciences, 1979.

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"A major energy transition of some kind is inevitable."

"Solar Possibilities," Denis Hayes, Worldwatch Institute,
Energy Journal, October 1979.

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"A careful inquiry suggests that sunlight could eventually be the primary, and even exclusive, source of heat, electricity, and synthetic fuels for the entire world, continuously and eternally."

"Global Aspects of Sunlight as a Major Energy Source,"
J. Weingart, Solar Energy Group, Lawrence Berkeley
Laboratory, *Energy Journal*, October 1979.

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"The Department of Energy and NASA are jointly conducting a (three-year $15.5 million) feasibility study to be completed in mid-1980 to arrive at an optimum engineering design. . .for the Satellite Power System [where] energy from the Sun is collected by an array of solar collectors in geostationary orbit and converted to microwave energy directed toward the Earth in a focused beam."

"Impacts of Satellite Power System Technology,"
H. Moses, U.S. Dept. of Energy, *Energy Journal*, October 1979.

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"OTEC can provide the U.S., and many of the nations, with a renewable resource at a price competitive with other technologies."

"Ocean Thermal Energy Conversion," Lavi and Lavi,
Carnegie-Mellon University, *Energy Journal*, October 1979.

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"We are faced with a grave problem. Since the industrial revolution, the industrialized nations have been engaged in a race to increase energy consumption in order to increase population and build great bases of political power."

"Energy conservation policies will be necessary on a massive scale to forestall shortages of both energy and material goods in the economy in future years."

"Avoidance of environmental and economic collapse is possible if the industrial societies shift the current emphasis on high growth into a transitional phase of planetary maintenance, not exploitation."

Energy for Survival: The Alternative to Extinction, W. Clarke,
Anchor/Doubleday Books, 1974.

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"To save our civilization, we must do more than curb air and water pollution. . .we must slow down the present rate of population growth."

"Many experts contend, however, that only a wide-ranging program can chart a way out of the present crisis. Such a program would implement all of the following: increased imports of oil and natural gas, technological efforts to improve efficiency of energy production, massive research efforts to develop fuel alternatives, and drastic changes in consumer demands."

"Although there is plenty of energy, it may not be available to Americans because of price, environmental effects, geographic and political considerations, or technological capability."

"The most urgent immediate problem facing America is the shortage of natural gas."

"S. David Freeman, head of a Ford Foundation study of the energy situation, points out: 'There are two things wrong with coal today. We can't mine it and we can't burn it. . .' In addition, coal is expensive and difficult to transport."

"We can thus say with some confidence that, under the assumption of no major change in the present system, population and industrial growth will certainly stop within the next century, at the latest."

"The internal combustion spark-ignition engine in use today—which may become a thing of the past long before 1994 comes around."

"1994: The World of Tomorrow,"
U.S. News & World Report, 1973.

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"Energy research now occupies tens of thousands of scientists and engineers in this country, and the R&D budget for the federal government alone exceeds $3 billion a year. Still lacking are the willingness to face up to an era of more expensive energy and a political consensus on how to deal with our changed energy circumstances."

"An Interim Look at Energy,"
Hammond, Editor, *Science*, February 10, 1978.

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"There's one basic answer to the energy crisis. We've got to shift as rapidly as possible from a 95% dependence on non-renewable fuels to full dependence on renewable ones. Otherwise, we're in grave economic danger."

Barry Commoner, "Energy Panel Looks to Sun as Solution,"
The New York Times, October 9, 1980.

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"Socio-economic development could fail for lack of adequate and economically priced energy and materials supplies, while competition for scarce and expensive resources could escalate."

Goals for Mankind,
A Report to the Club of Rome, 1977.

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"We are, however, running out of the cheap oil and natural gas that powered much of the growth of industrialized societies."

"It appears, then, that expensive energy is a permanent condition, even without allowing for its environmental costs."

"Energy in Transition," J. Holdren,
Scientific American, September 1990.

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"What seems certain, at least for the foreseeable future, is that energy, once cheap and plentiful but now expensive and limited, will continue to rise in cost."

Union of Concerned Scientists,
Energy Strategy, published 1980.

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"America is a country of energy drunkards. Alternate approaches to energy production and use are [the] most real because none of them require advanced technology or years to make practical. Greenhouses that grow food in winter with the help of the sun are available now, as are wood stoves, compost piles, thermal underwear, and bicycles."

Energy We Can Live With,
Ed., D. Wallace, Rodale Press, 1976.

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Table 2: Some Who Got It Right

The record of energy and technology-related forecasters of two decades ago is not entirely barren of visionaries who did guess correctly. But their views were either completely buried at the time in the mountain of expert studies and media frenzy, or pilloried. Two writers at the time saw the future differently than the mass wisdom. But they were ignored. Many constituencies had a lot to gain in political and economic terms, at least in the short term, by going along with, if not encouraging, the idea of energy shortages. (The parallels with the global warming debate here are obvious.) Consistently accurate in the arena of economic and resource forecasting, the recently deceased and brilliant thinker Julian Simon was, quite literally, a sane voice in a wilderness of intellectual inaccuracy:

> "Extrapolation of long-run cost trends. . .promises continually decreasing scarcity and cost [for energy], though this runs counter to popular opinion."
>
> *The Ultimate Resource*,
> Julian Simon, Princeton Press, 1981.

More visible, but no less ignored at the time, was Peter Drucker, who coyly claims he does not make predictions; he recently made the following observation about forecasts on the subject of energy:

> "In 1979, I made myself absolutely impossible by publishing an article in the *Wall Street Journal* in which I said the petroleum cartel—OPEC—is dead. I predicted that the price of oil would not go up any further, and I got more brickbats for that than I ever got in my life. . .I said that between 1980 and 2000 petroleum prices would not go above $20 a barrel."
>
> "Peter Drucker's Takes the Long View,"
> *Fortune*, September 28, 1998.

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"Coal has the potential to contribute substantially to future energy supplies. Although the resource base of other fossil fuels, such as oil sands, heavy oil, and oil shale is very large, they are likely to supply only small amounts of energy before the year 2000. . .Other than hydroelectric power, renewable resources of energy—*e.g.*, solar, wind-power, wave-power—are unlikely to contribute significant quantities of additional energy during this century at the global level."

Energy: Global Prospects 1985-2000,
Workshop on Alternative Energy Strategies, MIT, 1977.

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"It is still too early to make a reliable assessment of what can be accomplished in the next decade and beyond, and it would be premature to conclude that energy problems will necessarily constrain world economic development during this century or beyond."

"A major feature of the world energy outlook is the continuing trend toward greater use of energy in the form of electricity, but the rate of future electricity growth is projected to be slower than in the past."

"World Energy Outlook,"
Exxon Background Series, April 1978.

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"In the most general of terms, this book concludes that profitable and expanded petroleum and electric utility industries will be required if the nation is to stand any chance at all of developing a meaningful energy base now and in the future."

"Many special-interest groups would like. . .a crash program of commercial development of [unconventional energy systems] through heavy government subsidies."

Fuels for Tomorrow,
Dr. L. Rocks, PennWell, 1980.

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"Coal must be used in increasing quantities, and mainly with the current technologies, until at least the turn of the century, regardless of what happens with respect to such alternatives as nuclear fission or solar energy."

"The actual choice of which solar technologies to deploy should be made in as decentralized a manner as possible. In other words, the decisions should be left to private industry and individual consumers."

Energy in Transition 1985-2010,
National Academy of Sciences, 1979.

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"Of course, technological change is unpredictable, and a new wave of innovation could lower energy costs."

Energy in America's Future: The Choices Before Us,
Resources for the Future, 1979.

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"Inventions and innovations in technologies that are not motivated by energy-conservation goals (*e.g.*, introduction of new generations of motor vehicles, aircraft, entertainment facilities, such as color TVs, stereo systems, and video tapes) have played dominant roles in improving what many people view as their standard of living. These inventions and innovations have been responsible for rapidly escalating energy-use rates. In developing future scenarios for energy conservation, it is important to allow room for important inventions not yet conceived or not yet available (*e.g.*, personal electric vehicles) and for the corresponding radical changes in energy-use patterns that may accompany their introduction. Without this provision, the most benign energy-conservation scenarios may not justifiably be viewed as maintaining the quality of life."

"Challenges in the Implementation of Energy Conservation,"
S. Penner, Energy Center, U. California, San Diego,
Energy Journal: Special Issue: Renewable Energy Prospects,
October 1979.

Footnotes

1. "Countries with expanding industry, rapid population growth. . .will be hit especially hard by economic energy scarcities from now on." *World Energy Strategies*, Amory Lovins, 1974.

2. While beyond the scope of this paper, it is useful to note that widespread and profound advances in all aspects of technology have provided the fundamental drivers permitting rising reserves and production in the face of (actually because of) declining costs. See "King Faisal and the Tide of Technology," P. Huber, M. Mills, *Forbes*, November 16, 1998.

3. See *Federal Incentives for the Energy Industry*, September 1998. Management information Services Inc. finds that in cumulative constant dollars, the second-largest recipient of federal energy subsidies have been renewable energy sources at $90 billion over the past five decades. (Oil received the largest cumulative funding.)

4. Lucid and scientifically grounded illumination of the scientific realities of global warming can be found in the newsletter *World Climate Report* (see www.nhes.com).

5. It is useful to note that, by definition, the average temperature of the Earth's atmosphere has not been and cannot be constant. Over time, the atmosphere is either warming or cooling in cycles. It is the case that the Earth has been warming since the last Little Ice Age. An important consideration for humanity, again

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regardless of how warming might be induced (human or natural cycles), is whether it is better for the world to be getting warmer or colder; staying the same is not an option. Little has been said in the public debate about the debilitating human, agricultural, and economic consequences of global cooling.

6. There are other natural contributors to the greenhouse effect of course, including water vapor (which incidentally, is an aspect of the geophysics of the atmosphere that has been generally ignored in human-induced global warming computer models).

7. The models that are purported to support this theory predicted, twenty years ago, that the average world's temperature would have been measurably higher before the year 2000. It isn't. Again, for ongoing news about this scientific issue and, in particular, historic and current data showing global average atmospheric temperatures as measured by NASA satellites, see *World Climate Report* at www.nhes.com.

8. It is far from clear in the scientific literature that one can attribute human production of carbon dioxide as the primary cause of geologically recent increases in atmospheric concentration; without going into the details here, this uncertainty arises from a great deal of ignorance (although improving yearly) about the historic and "normal" levels of CO_2 in the atmosphere, and great uncertainties about natural sources and sinks of CO_2 which together are at least an order of magnitude greater than those associated with human activities. For example, it has only recently been learned that the United States is probably a net absorber of CO_2 (counting industrial emissions) because of agricultural uptake. (See *World Climate Report*, www.nhes.com, 10/26/98 edition.)

9. See for example, "EPA's Authority to Regulate Pollutants Emitted by Electric Power Generation Sources," U.S. EPA Memorandum of 4/10/98 from the EPA Office of General Counsel to EPA Administrator Carol Browner.

10. There are other byproducts which are produced resulting from incomplete combustion and the presence of contaminants in the carbon fuels; these are properly called "pollutants" and their production mitigated by various engineering schemes. Other chemical reactions are available to produce energy, principally that involving hydrogen and oxygen, the basis for fuel cells. The problem with hydrogen is that, although it is the most abundant element in the universe, for all practical purposes there is essentially none left on Earth; it must be produced as a byproduct from the constituents of natural gas or water.

11. To be fair to environmentalists, there are others in the global warming "game" who have much to gain by convenient association with schemes that are dominated by anti-coal proposals. Typifying this line of reasoning was the September 1998 announcement for The Aspen Institute whose headline says it all: "Top Energy, Environment Leaders Urge President and Congress to Depoliticize Climate Debate, Take Long View, Start Now."

12. *Taking Action on Climate Change: Debunking the Myths*, World Resources Institute, www.wri.org.cpi.climyths/.

13. Again, typical of this rhetorical argument are the following two conclusions published in eminent and credible journals: "Global production of oil from conventional sources [of oil] is likely to peak and decline permanently during the next decade." "Preventing the Next Oil Crunch," special section, *Scientific American*, March 1998; "As the peak in [oil] production approaches, prices will begin to rise and the United States will have to quickly shift to new energy sources to mitigate the impacts on its heavily oil-dependent economy." "Heading Off the Permanent Oil Crisis," James MacKenzie, World Resources Institute (WRI), *Issues in Science & Technology*, Summer 1996.

14. "A Special Moment in History," Bill McKibben, *Atlantic Monthly*, May 1998.

15. Once again, from WRI: "The actions needed to address the threat of climate change, however, provide an opportunity to chart a more sustainable course into the future as individual firms and national economies become more efficient, embrace environmentally sound technologies, and accelerate the transition to a global economy fueled by renewable energy resources." http:// www.wri.org/wri/cip/aboutcpi.html.

16. This goal is by no means isolated to global warming-inspired theories; see for example the June 25, 1998, "Proposed Changes to the Regional Haze Rule To Facilitate Grand Canyon Transport Commission Recommendations," from the Western Governors which contains the idea to establish a "renewable energy goal of 10% by 2005, and 20% by 2015" for Western states' total electric generation; See also "Mideast Oil Forever?" April 1996, *Atlantic Monthly*, authored by two U.S. Department of Energy employees.

17. *Scenarios of U.S. Carbon Reductions: Potential Impacts of Energy Technologies by 2010 and Beyond*, Interlaboratory Working Group on Energy-Efficient and Low-Carbon Technologies, prepared for the Office of Energy Efficiency and Renewable Energy, U.S. Department of Energy, September 1997.

18. After all, the billions already spent on renewables over the past two decades in federal and state programs and incentives have brought the nation to the unremarkable point of having a mere 0.1% of total energy supply from the favored alternatives of solar, wind, and geothermal.

19. It is obvious, but important nonetheless to state, that short-term price distortions can happen, have happened, and will continue to occur due to political meddling, geopolitical strife, and misguided policies; but over time such price variations disappear in the long-term price trends. Oil, for example, has oscillated around a price of $17/barrel (inflation-adjusted 1998—see *International Petroleum Encyclopedia*) for 100 years, with brief excursions below (rarely lower than $10) and above the median.

20. See for example excellent summary of historic price forecasts from the U.S. DOE's Energy Information Administration by Bruce Humphrey, "A Failure of Imagination," *Electric Perspectives*, May/June 1996.

21. "U.S. Oil Reserve Gains," *Oil & Gas Journal*, September 28, 1998, p. 27.

22. Note that the Audubon Society in 1981 suggested that efficiency investments would be partially paid back by future savings. They had not yet adopted the now bolder assertion from environmental organizations that virtually any, often expensive, energy efficiency investments achieve full pay back.

23. DOE/EIA Annual Energy Review 1998: Environmentalists and journalists are often loose in the implicit or explicit definition of both renewable and solar energy. To be sure, burning trash and wood, and large-scale hydro are frequently included in the broader "renewable" category—and some environmentalists even put wood and hydro in the "solar" category when attempting to disingenuously inflate the "solar" contribution (the Sun makes the trees grow and the water evaporate yielding rain and thus rivers. . .). As a practical matter when advocates say renewables and solar in particular, they are generally referring to, and most people take it to mean, solar cells and windmills, which provide minuscule amounts of energy for the nation. Even when all the other "renewable" sources are included (except large scale hydro which is universally reviled by environmentalists), the national contribution still does not break the single digit percent range.

24. *Energy Futures* was the most popular energy document of those days and was, in fact, issued as a book and became a best-seller, possibly the only best-seller ever on the subject of energy. The book also has the dubious distinction of being wrong in virtually all of its important forecasts. See Appendix Table I for a sampling of other forecasts from the Harvard group.

25. Data from DOE/EIA Annual Energy Review 1998, and 1998 Statistical Abstract of the United States.

26. For a representative compilation of new and emerging electric technologies, see "Breakthrough Technologies" published September 1998 by Mills-McCarthy & Associates Inc. See also "Electrotechnology Reference Guide," 1992, Electric Power Research Institute, as well as "Industrial Electrification in the Information Age," Schmidt *et al.*, Edison Electric Institute, July 1994.

27. MacKenzie's claim echoes that of the 1980 Union of Concerned Scientists' energy study. Perhaps not surprising, MacKenzie worked for the UCS before joining the World Resources Institute. "It is now abundantly clear that the world has entered a period of chronic energy shortages that will continue until mankind has learned to harness energy from renewable sources." Union of Concerned Scientists, *Energy Strategy*, published 1980.

28. *Imagined Worlds*, Freeman Dyson, Harvard University Press, 1997, p. 45.

29. When the president of the World Future Society published, in 1980, twenty-nine predictions for the next two decades, all of the forecasts those that were most egregiously wrong, related to how technology would impact the future of energy and resources. For example, reflecting the then popular Limits to Growth philosophy, the forecasts of 1980 included: mass extinctions, massive overpopulation, widespread destruction of ecosystems, terrorism against nuclear reactors, policies discouraging car ownership, battles over the control of seabed minerals. From "What if ..?" *Forbes*, November 2, 1998.

30. It may appear difficult to accept the fact that an electric application is, on average, more energy efficient than a combustion process. True energy efficiency is visible only in a total fuel cycle approach in which the energy losses associated with generating electricity are balanced against the efficiencies in every step of the energy food-chain. Two examples provide some insight. The electric car is, overall, more energy efficient than a gasoline car. (This does *not* mean necessarily more practical, because in this case fuel storage is so poor in electric vehicles.)

—The total fuel cycle efficiency of an electric car is about 21%. This is determined by the combined efficiencies of electric propulsion motors at 90%; batteries at 80%: the vehicle's drive system at 72%; and the efficiency of converting fuel to electricity and delivering of 30%.

—By comparison, a conventional automobile's total fuel-cycle efficiency is about 13% because of the combined efficiencies of a gasoline-engine at about 15%; efficiency of converting oil to gasoline and delivering it to market at about 90%. A more subtle example: the conventional means of drying paint (on a car for example) is with an oven heated by burning natural gas. This process is about 10% efficient; *i.e.*, even though gas can be burned and converted to heat with 95% efficiency, only about 10% of the thermal energy does the actual work of drying paint. Alternatively, electric infrared lamps are increasingly used to direct radiant energy at paint, with a paint-drying efficiency of 80%—counting the power plant efficiency of 30% this yields a total

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paint-drying energy efficiency of 24%, or 2.4 times better than the combustion technique.

31. *Standard Oil Company (Indiana): Oil Pioneer of the Middle West*, P. Giddens, 1955.

32. *Today Then: 1993 as Predicted in 1893*, compiled by Dave Walter, American & World Geographic Publishing, 1992.

33. Such time lags are not relevant for improvements in, or variants on, a basic technology or invention. The time cycles for improvement are sometimes extremely fast. Rather the time periods referred to here regard the emergence of a core idea, an electric light, a car, an airplane, a transistor, etc.

34. As one who was employed in the research and development aspect of integrated circuits in the mid-1970s, the possibilities seemed enormous to me; but I recall being struck at that time with the lack of practical interest in imagining such things, perhaps because they were relatively far away in time and were certainly substantially removed from the day-to-day demands of the job and company. In speculating that the integrated circuit technology we were developing then would make the possibility of true Dick Tracey-style communication feasible in a decade or two, I found the idea roundly labeled as improbable if not silly.

35. The real problem with solar energy is, of course, simple: regardless of the technological tricks to convert light to energy (something plants do wonderfully), the Sun's energy once it arrives at the Earth's surface is too weak to be practical for the energy needs of our industrial society. Indeed, were the Sun's energy powerful on arrival at the Earth's surface, there would be no life on Earth. Energy technology progress has always been characterized by movement towards increasingly concentrated forms of energy.

36. *Harvard Business Review*, September/October 1997.

37. In a special issue devoted to near-future advances in technology, *Scientific American* magazine's editor noted succinctly: "Why do some innovations fall so far short of what is expected of them, whereas others succeed brilliantly? One recurring reason is that even the most knowledgeable forecasters are sometimes much too optimistic about the short-run prospects for success. . .To survive, a commercial technology must not only work well, it must compete in the marketplace." *Scientific American*, September 1995.

38. "Technology of the Future," John Gordon, *American Heritage*, October 1993.

39. "A Special Moment in Spin Control," Mills, *World Climate Report*, May 11, 1998.

40. One of the currently popular neo-Malthusians, Bill McKibben, recently attempted to resurrect the credibility of his and his colleagues craft: doomsaying. In a lengthy April 1998 *Atlantic Monthly* essay McKibben tackles the 200-year failure record of Malthusianism. With superficial daring McKibben admits that, "Each new generation of Malthusians has made new predictions that the end was near, and has been proved wrong." And later: "So Malthus was wrong. Over and over again he was wrong. No other prophet has ever been proved wrong so many times. At the moment, his stock is especially low."

41. The idea that somehow this generation, dominated by baby-boomers, has discovered it all, and knows it all, has surfaced frequently, perhaps most dramatically in Francis Fukuyama's book *The End of History*.

42. *Imagined Worlds*, Freeman Dyson, Harvard University Press, 1997.

43. *Forbes*, ASAP, September 1998.

About the Author

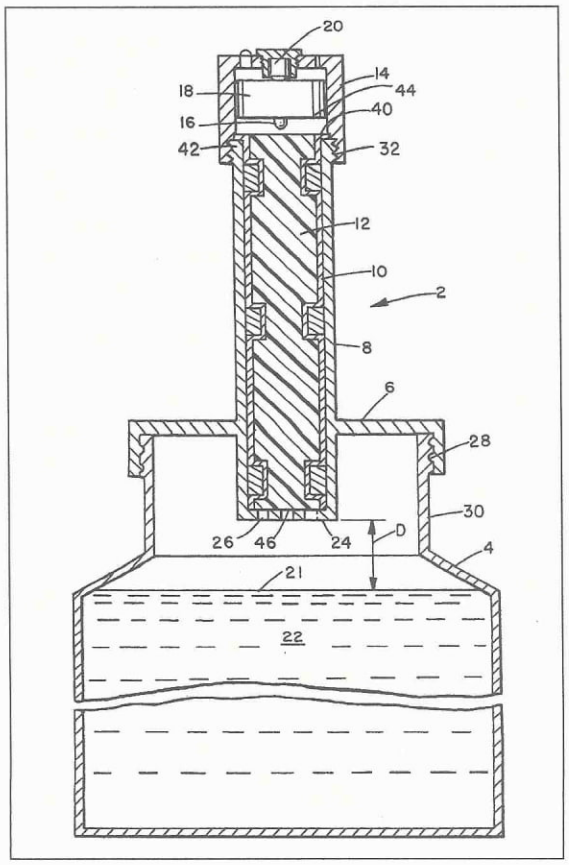
Mark P. Mills is president of Mills-McCarthy and Associates Inc. (MM&A). MM&A is a Washington, DC-based research and consulting firm specializing in technology strategy focused on the energy industry. Mills is the founder and publisher of the national newsletter *Breakthrough Technologies*, which covers new and emerging energy-related end-use technologies. He has worked with over eighty utilities in providing strategic plans, marketing support, speeches, seminars, executive briefings, expert testimony and analytic research. A physicist by training, Mills holds several patents in the fields of integrated circuits, fiber optics, and solid state devices. He also pioneered a quantitative approach to accounting for total fuel cycle energy and environmental benefits of the use of electricity, and has produced groundbreaking research on the role of electrotechnologies and electricity in the economy including a commodity-based model of kilowatt-hours. A frequent expert witness in hearings before Congress and state legislatures, Mills has served as a staff consultant to the White House Office of Science and Technology Policy (under President Reagan), a number of National Research Laboratories, the Congressional Office of Technology Assessment, and the U.S. Department of Energy.

Jed Rothwell's Rebuttal begins on page 28

Method and Device for Producing Activated Liquids and Methods of Use Thereof

United States Patent Number:	6,022,479
Date of Patent:	February 8, 2000
Inventor:	Igor Smirnov 3375 Calle Odessa Carlsbad, CA 92009
Filed:	July 22, 1998
Application Number:	09/120,789

Abstract: A device and method are disclosed which activate aqueous liquids, particularly water, and liquid polymers, resulting in enhanced properties in chemical and biological processes in which the activated liquids are used. The device includes a liquid reservoir; an activation body formed of a polymeric matrix containing a number of finely divided materials, with the body disposed in a strong (2,500 - 25,000 Oersted) magnetic field and responsive to visible electromagnetic radiation having a frequency of 7.2 - 7.8 Hz and a wavelength of 400 - 800 nm, and with one end disposed proximate to the surface of the liquid; and an electrical circuit adjacent the other end of the body, activating diodes to emit flashes of light having that wavelength and frequency, so that the materials and the polymeric body are energized and emit low frequency oscillations, which activate the liquid contained in the reservoir. Polymers include polyurethanes and epoxies. Materials include metals, metal salts, organic compounds, and natural minerals and mineral containing bodies. Concentrations are in the range of 0.04 - 30 parts by weight per 100 parts by weight of polymer. Also described are a number of methods of use of activated liquids, particularly water, including reducing alkalinity, acidity or hardness of water, reducing bacterial content of contaminated water, enhancing the setting time and compressive strength of concrete, and enhancing the growth rate and viability of plants. Physiological effects on cells and viruses as well as in humans have been observed with water activated as described.



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MARK MILLS Could Not Have Got It MORE WRONG

Jed Rothwell

Getting It Wrong by Mark Mills is a travesty. Mills is a biased spokesman for the coal mining industry. He is affiliated with the Competitive Enterprise Institute and the Greening Earth Society, the public relations arm of the coal mining Western Fuels Association.

This paper is factually wrong in every important detail. It is intellectually dishonest, narrow minded, contradictory, and ignorant of history, physics, and engineering. Although this is supposed to be a technical paper, Mills did not include quantitative analyses, tables, or graphs, probably because he is innumerate and he has learned to avoid making a fool of himself. Elsewhere, he has repeatedly claimed it takes a pound of coal to transmit 2 megabytes (MB) of data via the Internet. This works out to be ~0.5 kWh (900,000 joules) per MB. This much electricity would cost 4 cents, whereas data transmission costs 0.11 cents per MB, and energy is only a tiny fraction of that cost. Mills says he holds a patent for fiber optic technology. He should know that it takes only 0.13 joules to send a megabyte across the Atlantic with a fiber optic cable, seven million times less than his estimate.

Mills testified before Congress that personal computers consume 1,000 watts on average. In a more recent co-authored publication in April 2001, the authors say "several hundred watts." In fact, desktop computers use 150 to 200 watts. Many people have told Mills he is wrong, but he keeps repeating this nonsense. It has been published far and wide, in *Forbes*, the *Wall Street Journal*, and in speeches by president Bush and the Secretary of Energy.[1,2] Apparently, these reporters and politicians lack hands-on knowledge of everyday machines. Anyone can see that Mills is wrong by looking at the maximum power rating on the back of a computer, which is well below 1,000 watts. You can measure actual power with a simple inductive ammeter and volt meter. Many people have told Mills his estimate is absurd, but he keeps repeating it. I am forced to conclude that Mills is either stupid, or he is misleading the public with the "big lie" technique: repeating nonsense so often and so loudly that it drowns out the truth.

Mills is often at war with both common knowledge and expert opinion. He testified that the Internet plus computers consume 13% of electricity generated, and in ten years they will consume about 50%, creating a tremendous boom in the demand for power. The DOE, the Edison Electric Institute, EPRI, and all other government and industry sources agree the correct figure is roughly 3%, that computers and the Internet have reduced energy use overall, and the next generation of desktop computers are likely to consume less, or about as much as today's laptop machines. Mills has sometimes backed off from these incredible errors. He said he "no longer cares" what percent of electricity the Internet consumes. "I have chosen not to engage in the question of whether it's 5% or 6% or 8%."[4]

In *Getting It Wrong,* Mills makes dozens of ignorant mistakes. Describing his fetish, the non-existent "enormous electric demand from . . . PCs and the associated industry to fabricate them . . ." he says, "Modern multi-billion-dollar integrated circuit 'fab' plants rival steel mills in scale and cost." The size and cost of a building do not indicate how much energy it uses. The largest fab plants consume $5 million in electricity per year (high grade, expensive energy), whereas a typical steel mill consumes roughly $50 million in cheap fossil fuels. The silicon fabrication industry consumes roughly 1.1% of electricity, or 0.3% of all energy, whereas steel accounts for 2 to 3% of total U.S. energy. Energy is a major expense at steel mills, and profit margins are thin, so intense efforts have been made to conserve. Energy is a large fraction of the operating expenses at a fab plant, but operating expenses are trivial compared to the cost of the equipment, which becomes obsolete in a few years. A $5 million electric bill is hardly noticed. That is changing, especially in California, where cheap methods to cut consumption are being rapidly introduced. One plant reduced power from 627 kW per wafer in 1994 to 90 kW in 2000.

Moral Failure: Denying The Real Energy Crises

Mills claims there is no shortage of energy, a point of view I find sickening. There is no physical shortage in the U.S. Most people can afford energy, although in December 2001 nearly 50,000 families in Atlanta, Georgia had their heat cut off because they could not pay the natural gas bill.[9] In two-thirds of the world, there is a grave shortage of affordable energy, and there always has been. Most people cannot buy enough fuel to cook meals, sterilize water, or keep warm in winter. Thousands die every week mainly for lack of energy. People are forced to cut too much firewood, deforesting large areas. They burn kerosene indoors to extract as much heat as they can, which causes respiratory illness and acute danger from fire. Fossil fuel is too expensive because it is bulky, and it requires elaborate equipment to dig, ship, and handle. It will never be produced cheaply enough to meet the needs of

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most people in the world. As Mills points out, the price relative to inflation has not fallen in 100 years. It was too expensive in 1900, and it still is.

Mills is so blind to the shortcomings of his industry, he thinks only two objections to oil have been raised:

1. That it will run out. He dismisses this as a discredited argument from the past, despite overwhelming proof that oil is, in fact, running out. Production peaked in the U.S. in 1970. No one would build a platform in the North Sea if enough oil could still be found in Texas.

2. That it may cause global warming, which he denies. The environmentalists play into his hand on this issue. They harp on global warming, which may not exist, or if it does, it might not become serious until the distant future. They should emphasize here-and-now problems such as pollution, war, terrorism, and massive trade deficits.

Here are some major problems with fossil fuel that Mills does not acknowledge:

Coal and oil pollute the air. Millions of people in cities like Atlanta and Los Angeles hardly know what "fresh air" means. A sickly yellow-brown pall is visible for hundreds of miles around cities. Smog kills trees, and ruins buildings and ancient monuments. It hurts people's health. On some days, the air is so bad people are advised not to exercise.

Gasoline is dangerous. After a collision it can leak and explode. Most victims of air crashes are killed by fire, not the impact.

Gasoline is toxic, and corrosive. It leaks out of underground tanks, contaminating ground water. When burned, it generates carbon monoxide and carbon dioxide, so it cannot be used indoors.

Gasoline engines are noisy and prone to breakdowns, especially the hand-held ones in things like leaf blowers. They are mechanical absurdities. They cannot stop or run slowly, so they require elaborate, inefficient gears and clutches. They are the wrong size for most applications. Fossil fuel engines cannot be scaled down to a convenient size for most machines, such as personal computers, light bulbs, and toasters. Since the fuel cannot be used directly, much of it has to be converted to electricity in central stations far from cities, wasting two-thirds of the energy.

Fossil fuel does not have the reliability or energy density we need for revolutionary applications such as nanomachines, or permanent implanted mechanical hearts and heart assist pumps with enough energy to run for a lifetime. Our civilization is poised to undertake great projects. We will irrigate deserts, colonize other planets, and terraform Mars. We will clean up the mess our ancestors made here on Earth. It is time to raise our expectations and our standards of environmental cleanliness, and to rekindle the spirit of adventure. The resources of the solar system will be ours in a few generations, if we have the will to harvest them. Fossil fuels cannot do the job. We need energy a million times cheaper and cleaner.

Fossil fuels are most prevalent in places like Iraq, Saudi Arabia, and the former Soviet Republics. These nations are under the thrall of tyrants, who subject them to constant turmoil. They steal the vast profits from oil and squander it in wars, sometimes dragging in the U.S. and its allies. The trade imbalance from oil impoverishes millions of Americans. If we produced the fuel here, from wind or nuclear power, or some other domestic source, the money and the jobs would stay here.

Cold fusion would fix these problems. Renewable energy would fix some of them. Wind power might be used to synthesize liquid fuel for fuel cells, which is not flammable or toxic. Some types resemble window cleaning fluid. Chrysler has developed the "Natrium," a fuel cell "concept minivan" that runs on borohydride, or borax, the active ingredient in many detergents, which is not very toxic. Fuel cells have much higher energy density than batteries. They can be used indoors, since they produce only electricity and water, not carbon monoxide. They can be made small enough to power a cell phone, or large enough for a household generator. Fuel cells under development will be big enough to run shopping malls and factories.

Most Government Support Goes to Fossil Fuels

Mills and his organization pretend to support free-market capitalism, but fossil fuel is anything but competitive. It survives by derailing competition, mainly by influencing Congress to write tax laws that reward waste, pollution, and inefficiency, such as depletion allowances. The wind energy Production Tax Credit (PTC) partly makes up for this, but most observers say that fossil fuel companies on average pay substantially lower taxes than other corporations.[9]

Most government support goes to fossil fuel and nuclear power. Subsidies for fossil fuels and nuclear power total $2.8 billion. Subsidies for renewable energy include $725 million for alcohol made from corn, and $342 million for wind and solar. Research budgets favor nuclear and fossil fuel:

Millions of dollars, Fiscal 1999 (U.S. DOE)

Basic research	$2,765 (includes $233 for plasma fusion)
Nuclear	$640
Coal	$220
Clean coal project	$183 (total for coal is $403)
Oil and gas	$163
Solar	$99
Wind	$35

"Basic research" is a catch-all category that includes "basic" or "general science" ($1.6 billion). This mainly goes to big-ticket particle detectors and nuclear bombs. It includes "general energy research" ($822 million), meaning things like conservation and plasma fusion. The DOE explains: "Basic research expenditures include Government funding for fusion research and the [now defunct] superconducting supercollider, which represent subsidies for the development of scientific knowledge in general, rather than for energy in particular. They are not treated as direct energy subsidies in this analysis . . ." (In other words, the DOE does not count plasma fusion as energy research, despite what it tells Congress every year to justify the program.)[10]

Getting Energy and Environmentalism Wrong

Mills says that "every environmental organization" in 1980 "promised . . . a bleak future." There were many upbeat, mainstream environmental organizations in 1980, such as the Audubon Society, farm bureaus, and hunting and game

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preservation societies. They assumed we are making progress and we have the will and the means to fix problems. Support for environmentalism has been broad based. Theodore Roosevelt was its first national champion. The railroad companies contributed land and political support to the national park system. Richard Nixon was no liberal, and he did not expect a bleak future, but he supported and signed the Endangered Species Act in 1973.

Mills admits that a solar or wind installation is "gratifying," but he agrees with Vice President Cheney, who said, "Conservation may be a sign of personal virtue, but it is not a sufficient basis for a sound, comprehensive energy policy." Mills seems stuck in a time warp circa 1968. He thinks only hippies who read the *Whole Earth Catalog* conserve energy. Many mainstream leaders and economists say conservation is essential to competitiveness and national security. Consider the Board of Directors and Officers at the Alliance to Save Energy. It includes four Senators, the former president of Osram Sylvania Inc., a partner at Ernst & Young LLP, the CEO of Honeywell, directors at DOE National Laboratories, the CEOs of Washington Gas and Exelon (major gas and electric companies), the president of the Edison Electric Institute, an industry association whose members supply 70% of the nation's electricity, and vice presidents from Johns Manville, Fannie Mae, and Whirlpool Corporation.[11] Conservation is an important mainstream business.

Mills writes: "The restructuring of our entire energy infrastructure and economy is based on fear of carbon dioxide," meaning the fear of global warming. He worries that "at stake are literally trillions of dollars in net present-value capital assets in today's energy infrastructure." First, as I said above, global warming is not the only concern. Pollution, health, and high cost are here-and-now problems. Second, switching to conventional alternatives such as wind or biomass would not call for the restructuring of the economy or the demise of the infrastructure. On the contrary, the infrastructure would be expanded and upgraded. The change would proceed gradually, as plants wear out. It would be good for the domestic economy, reducing oil imports and increasing employment. The energy infrastructure wears out and has to be replaced every fifty years in any case, so we might as well replace aluminum power lines with superconducting wire, and retrofit natural gas pipes to make them sufficiently leak-proof to carry hydrogen.

In this regard, cold fusion is quite different from conventional alternative energy. Because wind is intermittent, wind power requires a distribution network. It is only cost-effective with huge turbines, mounted on high towers, to sweep a large area and reach heights where the wind blows constantly, as a kite enthusiast knows. Power company executives will decide when and where to install wind farms. They will not abandon nuclear or coal generators ahead of schedule, or jeopardize their profits. Individual consumers will decide to buy a cold fusion heater. They will buy so many, the prices will quickly fall, and they will bankrupt all conventional energy companies, including fossil fuels, nuclear fission, the electric power companies, and wind turbine manufacturers. The energy infrastructure will be abandoned in place.

Mills says carbon dioxide is "not a pollutant," because it is not toxic, and is an "intentional product of activities needed to obtain energy." All pollution is intentional, and toxicity has little to do with whether a substance is a serious pollutant or not. Salt is not toxic, and salt in the ocean is not pollution, but when tons of salt are used to melt snow on roads, and it washes off into fields, it ruins cropland and rivers. Sulfur is a valuable chemical, but not when it is dispersed in the atmosphere. Ozone in the upper atmosphere is essential to life on Earth, but ground level ozone produced by automobiles is toxic pollution. All the substances on Earth have been here since the planet was formed. They are all benign in some locations or when bound in certain chemical compounds, and are harmful in others. Pollution is misplaced resources: valuable substances in the wrong place. There are legitimate doubts about the global warming hypothesis. But the fact that carbon is already present in the atmosphere does not mean that increased carbon concentration will not cause harm. Elsewhere, Mills and his Greening Earth Society claim that increased carbon dioxide would actually be a benefit, because it would spur plant growth. There is no reason to think that more plant growth would be good for the ecology or the economy. Farmers would probably find that weeds grow faster than crops. In the U.S. southeast and many other parts of the world, fast growing plants, especially non-natives species such as kudzu, are destroying millions of acres of productive land and wilderness. Most changes to the environment are deleterious.

Mills claims that windmills are "neither new nor revolutionary." They have reached maturity and will not improve much. All technology is a mixture of old and new, but wind turbines owe more to the twentieth century than any previous. Picture book Dutch windmills resembled sails. Modern wind turbines are airfoils made of glassfiber-reinforced-plastic (GRP) and they require sophisticated microcomputer control. Serious research and development on them began in the 1970s. Mills says that eighty years after their discovery, photovoltaics are well understood, and little future progress can be expected. Semiconductors were introduced fifty-four years ago, but no one says they have reached the end of their development. Coal was discovered thousands of years ago, and it has been the focus of intense research for centuries, yet Mills predicts major improvements in coal technology.

Mills often looks at only one side of a question. He says wind turbines are not "new" and he forgets that coal isn't either. He does not realize that one technology may balance out or cancel the need for another. He warns that computers use almost as much electricity as lights. He forgets that computers are themselves lights. They substitute for much of the overhead lighting in modern offices. Half of the energy consumed by a computer goes to the screen, where it illuminates at the desktop level, just the spot where light is most wanted. This reduces the demand for overhead light. A video screen is an inefficient way to generate light compared to a fluorescent bulb, but next-generation LCD computer screens will be more efficient than fluorescent bulbs. The more computers you install, the less you will pay for lighting.

Getting History and Economics Wrong

Mills makes many grating errors about history, economics, engineering, and other subjects. Here are a few examples:

Mills tries to make George Westinghouse look foolish, by quoting him out of context. This is like trying to make George Washington look unpatriotic. Mills quotes Westinghouse from 1893, "a speed of 90 to 100 miles an hour could be secured with modern locomotives and with

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improvements which are sure to come."[12] Westinghouse meant what he said: locomotives in 1893 could go 100 mph. He went on to say that although trains could go faster, in the future most would probably go about 40 mph, because this is economical and safe. That turned out to be a little optimistic. Most trains carry freight, the national average speed is 30 mph,[13] and it seems unlikely trains will ever go faster. A few passenger trains in France and Japan have achieved straight track speeds as high as 160 mph. Their average speed in actual travel is lower because of braking, the distance between stations, curves, and other factors that Westinghouse spelled out. Rapid trains are powered by electricity, just as he predicted. (He invented the first electric trains.) Mills says, "Westinghouse, in 1893, thought about travel in 1993 in terms of how fast trains might travel—which he egregiously underestimated in any case. Others, not involved in the rail industry of 1893, foresaw a future enhanced by far faster and different forms of travel, including aviation, despite the fact that the Wright brothers' first historic flight was at that time a decade away." Westinghouse did not egregiously underestimate; he overestimated slightly. He was talking about ground-level locomotive drawn railroad trains, not aviation, automobiles, elevated trains, trolley cars, or any other vehicle. He knew that lighter vehicles could safely attain faster speeds.

Mills ridicules journalist J.H. Beadle for saying we shall have a kind of "storage battery no bigger than a brick" with enough energy to plow fields and heat dwellings. I predict we will: a cold fusion cell!

Mills often quotes Amory Lovins: "the long-run supply curve for electricity is as flat as a Kansas horizon." Mills thinks "supply curve" means supply, that is, the amount of power produced. Actually, it is economics jargon meaning the amount of goods producers are prepared to sell at different prices. Lovins is saying there is no longer much economic advantage to large, centralized generators. Lovins wrote to Mills several times, patiently explaining: ". . . a supply curve relates the quantity of supply to its marginal cost. As I foresaw, smarter technologies have made that cost flat or declining as generation has risen. This trend is now accelerating as ever cheaper decentralized options—co- and trigeneration, fuel cells, renewables—begin to turn central thermal stations into toast. . .[Mills *et al.*] thus seem to have confused a supply curve with a projection of demand over time."[14] Mills can confirm this definition in an economics textbook, yet he has repeated this mistake over and over, three times in this paper alone. Again, either he is stupid or he is using the big lie technique, and hoping his readers will not bother to look up "supply curve."

Mills repeatedly attacks Malthusian projections. Malthus defined a law of nature: unchecked population growth is exponential, and it leads to a die off from starvation or increased predation. This was an important building block for the theory of evolution. Malthus understood that humans have avoided a crisis with improved agriculture and contraception.[15] Mills say Malthus made "a failed prediction." This is like saying the germ theory is wrong and bacteria does not cause disease because we discovered antibiotics. We have not escaped or nullified Malthusian laws in any sense, any more than people on an airplane escape the law of gravity. We take advantage of one phenomenon to counteract or suppress the effects of another. We have not fully counteracted Malthusian over-population. Population pressure does cause terrible problems. Millions of people live in wretched conditions, and so much land must be devoted to farming and living space that other species are endangered. Obviously, there are physical limits to arable land, water, and other resources. The "green revolution" cannot multiply crop density indefinitely. At present, roughly 40% of useable land area is devoted to growing crops or living space. I predict that cold fusion powered indoor food factories will produce more food than outdoor agriculture, but they too will have practical limits.

Mills has dug up some fatuous predictions, but some of the ones he lists at the end of the essay seem correct and uncontroversial. Does he contend there is no "instability" in the Middle East? Does he doubt that "a major energy transition of some kind is inevitable?" Every political leader and scientist agrees that "to save our civilization, we must do more than curb air and water pollution . . . we must shut down the present rate of population growth." Perhaps Mills believes air and water pollution have been eliminated and he does not realize that third world population is expanding at record speed. (The rate of growth and number of children per woman has declined, but absolute numbers of children being born is at record levels.)

Caricature of Environmentalist Views

Mills says environmentalists twenty years ago "exhibited a rampant pessimism about technology's ability to resolve contemporary problems or crises . . ." He insists that environmentalist forecasters "are not (and perhaps cannot be) optimistic about . . . fundamental technology changes . . ." Mainstream environmentalists advocate new technology to reduce pollution and conserve energy. To limit population, they want economic growth and education for women. In the 1970s a few anti-technology, back-to-earth Luddites frightened the public with best selling books featuring lurid predictions of mass starvation and the like. Mills seems to have read only the extremists.

Mainstream environmentalists want to distance themselves from the extremists, to avoid being marginalized. They want to play a legitimate, respected role in the establishment, so they will be funded and given a role in making policy. They are willing to compromise with corporations, the military, and other conservative institutions. By and large they have succeeded, and environmental progress is being made in developed nations. Unfortunately, because they are so anxious to be part of the establishment, very few mainstream environmentalists have taken the time to properly evaluate cold fusion and give it the support it deserves.

Mills claims (in footnote 22) that environmentalists advocate "virtually any" efficiency investment, and they think all investments achieve "*full* pay back." This is absurd. Most environmentalists are educated, and they understand accounting.

It is ironic that Mills singles out Amory Lovins as a naysayer, an alarmist, and a pessimist. Many environmentalists think Lovins goes over the top in his enthusiasm for new technology. In other venues, this debate over who is the optimist and who is the pessimist has become confusing and recursive. Environmentalists accuse the anti-environmentalists of being too sanguine and not paying enough attention to hard-nosed cost-benefit analyses. Many experts say that a

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controversial book by Bjorn Lomborg[16,17] downplays the seriousness of environmental problems, and underestimates the cost society will have to pay to fix them. David Nemtzow of the Alliance to Save Energy writes:

> Lomborg cites statistics about the wonderful potential of energy efficiency that would make Amory Lovins blush, but does not concern himself with the economic, political, social, and technical investments we need to make before we can take advantage of this enormous opportunity to mitigate energy's steep environmental costs. Like a variant of the old joke, when it comes to energy efficiency and renewables Lomborg would indeed like to get to heaven—he just doesn't want to do what it takes to get there.[18]

Mills claims that U.S. electricity and energy consumption in general has increased, and it is likely to increase dramatically in the future. He does not say this will only happen if the population increases and efficiency remains roughly where it is today. Since 1950 *per capita* energy consumption has increased modestly, from 229 to 350 million Btu, equivalent to 16 kg of gasoline per day in 1950, and 24 kg today.[19] (See Figure 1.) However, the U.S. population doubled, so total consumption climbed from 32 to 98 quads. Thanks to increased efficiency, consumption increased modestly while the *per capita* GDP tripled. Mills claims there has been a "continual flood of new technologies that use electricity" and he criticizes the environmentalists who predicted that once most houses had refrigerators and lights, future demand would not grow. The environmentalists were correct. If a flood of new technologies were consuming more electricity, *per capita* primary fuel consumption would increase. Mills correctly states that central power generator electricity claims an increasing share of overall energy consumption, but the increase has been gentle and predictable, from 14% to 41% over a half-century. Since primary fuel *per capita* consumption is steady, most of this increase must have been caused by electricity replacing the direct use of coal in things like blast furnaces and space heating. A close look at the numbers bears this out. In 1950, 34% of residences used coal heating, and less than 1% used electric heating. Today the numbers are reversed: less than 1% use coal and 30% use electricity.[20] Personal computers first reached households around 1982. Since then, the fraction of electricity devoted to all appliances, such as clothes dryers, ovens, televisions, and computers has edged up from 62 to 66%.

There is no question we can still reduce consumption without interfering in people's lifestyle. We are far from the thermodynamics limits of most machines. Our economic competitors in Japan and Europe have already developed more efficient equipment. We could buy it from them more cheaply than we buy oil from Saudi Arabia. It must be cheaper: if it were not, the Japanese government and corporations would not have bothered to invent it. They do not care much about the environment. Japan is picturesque in places, but most of the country is heavily polluted. The streets, waterways, and the Inland Sea are clogged with filth and trash. Construction companies lay waste to the land at a frightful pace, mainly building government-sponsored make-work follies such as roads and dams that no one really needs. Although Japan has 4% of U.S. land area, and half the population, it uses more concrete each year than the U.S. does.

Mills predicts that primary energy use will continue to expand at historically rapid rates in the U.S. That will only happen if three trends continue:

1. The U.S. continues to admit millions of immigrants per year. Natural population growth is close to zero.
2. The populations of Mexico, South America, and the other main sources of immigrants continues to skyrocket. Growth in these countries appears to be slowing down, although it continues in many third world nations.
3. The U.S. energy intensity remains high. This is the ratio of energy expended for each dollar of productivity:[21]

Russia	72,133	Btu per dollar of GDP
China	34,514	Btu/$
Kuwait	29,483	Btu/$
Mexico	17,766	Btu/$
Bolivia	17,727	Btu/$
Canada	17,401	Btu/$
Turkey	14,850	Btu/$
U.S	12,638	Btu/$
U.K.	8,365	Btu/$
Italy	6,700	Btu/$
Japan	6,523	Btu/$

Poor countries spend more on energy for each dollar of productivity than rich ones, because they use obsolete, inefficient machines and inflexible fuel such as coal. They waste more energy and generate more pollution. China, for example, still manufactures coal fired piston steam locomotives, which convert only 6% of the heat into propulsion. Modern

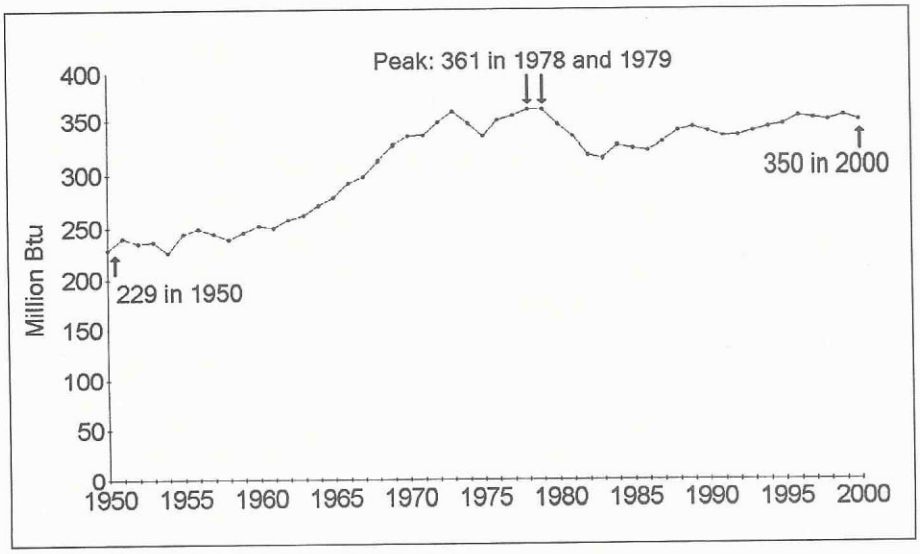

Figure 1. U.S. *per capita* energy consumption.

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electric or Diesel-electric locomotives are 32% efficient, but the Chinese are not skilled enough to make them. It is a cruel paradox that poor families cannot afford to live frugally. According to the World Bank, two billion people have no electricity, so they are forced to use kerosene lamps, which are much less efficient than electric lighting.[22] Contrary to Mills' flawed postulations, the last thing poor countries need is more fuel. They could expand their GDPs three to five times over without spending an extra dollar on fuel.

The U.S., Canada, and Kuwait waste energy because they have so much available, although it hurts them competitively.

The National Geographic is Not Authoritative

Mills pretends to be a maverick, challenging "the experts," but the people he attacks are not experts. He cites articles in *National Geographic* and *American Heritage*. These are fine publications, but they are not original sources, authoritative or up-to-date. He ignores textbooks, studies from the DOE, EPRI, the Edison Electric Institute, and articles from *Scientific American, Science,* and *Business Week*. These articles are level-headed and realistic. They describe progress in controlling pollution, improved recovery from oil wells, and much else that Mills pretends the public never hears about. Mills turns a deaf ear to experts in other industries. He claims that Internet routers consume 1,500 watts. Lovins and others have sent Mills literature and an e-mail message from a senior engineer at Cisco, the world's leading router manufacturer, emphatically refuting this:

> Nothing that follows is proprietary. But the public stuff on the Cisco website would be hard to put in perspective without talking to someone who is somewhat knowledgeable about contemporary networking technology. (There is no evidence that [Mark Mills] did anything of the sort.)
>
> "A typical router is a 1.5 kW machine, not counting peripheral equipment, cooling, etc." is really off the mark. . . .
>
> Cisco's *highest-end* router, the 12000-series, draws 1.5 - 2 kW. These are used for Internet backbones . . . Probably several thousand have been sold over the past year or two. . .Cisco has about 88% of market share for this size router.
>
> The biggest-selling router has been, in the past, similar to [the 2500 series, nameplate-rated at 40 W, which]. . .is at the high end of "typical" [intensity]. Over a million of them have been manufactured. The router of the more-immediate future, starting within the past year, is something like the 800-series baby. It's smaller and draws all of 20 W. Hundreds of thousands of them have been sold . . .
>
> . . . There are probably at least a million routers out there but the vast majority of them are small.[23]

Mills may not trust information from Lovins. He should contact Cisco directly, and read their product specifications. Most corporations are happy to share information, especially with people who have testified before Congress and published in *Forbes*.

We Are Running Out of Oil

U.S. consumption of oil has increased only modestly from the years when the nation was self-sufficient. In 1970, the U.S. produced 10 million barrels per day, and consumed 15. By 1996, production dropped to 6 million barrels, and consumption increased to 18.[24] (See Figure 1.) Most experts agree this is because U.S. oil fields are depleted. Some say U.S. production is down because foreign oil is cheaper, but this amounts to the same thing: it is cheaper mainly because overseas oil fields have not yet been depleted. In any case, when consumption fell in 1978, imports were reduced while domestic production remained steady. (See Figure 2.) Perhaps this was policy, and it would have been cheaper to import more, but in any case, it shows that domestic oil is still the first choice, and we would produce more if we could.

Mills apparently thinks that only radical environmentalists believe oil is running out, and everyone else thinks it will last for centuries. Most industry experts say it is running out, and more to the point, they agree it is obsolescent, and it no longer meets society's needs and enhanced standards for cleanliness and health. These experts include the CEO of BP, and the chairman of Shell Oil, Phillip Watts, who recently described Shell's initiatives in hydrogen power and wind energy: "One thing I am convinced of is that the next fifty years is not going to be more of the same. An energy company had better make sure it has the necessary expertise and knowledge."[25]

Could these experts be wrong? One should not automatically accept authoritative pronouncements, or assume that people promoted to high positions are smart. Large organizations like Enron are sometimes run by fools. Executives at Shell and other large energy companies I have spoken with have not read the cold fusion literature, so they know nothing about it. Cold fusion is a relatively obscure subject, whereas everyone knows that the future availability and likely cost of fossil fuels, upcoming improvements in drilling and refineries, customer expectations, marketing,

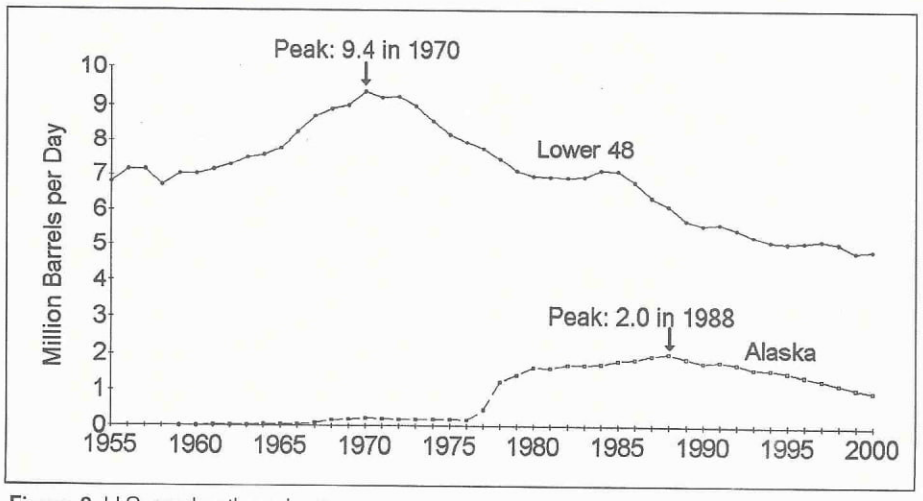

Figure 2. U.S. crude oil production.

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regulatory initiatives, taxes, and so on are critical issue in the oil business, so the CEOs of BP and Shell must have read all about them. Some oil executives disagree with Phillip Watts. Exxon has not launched major initiatives to deal with the post-oil era. Evidently, Exxon executives think that BP and Shell are moving prematurely. However, no industry executive disputes the fact that supplies of oil are finite, they are running out, remaining supplies will be more expensive to drill, and customers want cleaner, more flexible, premium quality energy. Since 1999, Texaco has invested almost $3 billion in alternative energy projects, such as advanced battery and hydrogen storage.[26]

Mills sees himself as a forward-looking, enthusiastic supporter of new technology, but the truth is that he opposes or dismisses energy innovation in all fields except his own: fossil fuels. Hundreds of breakthroughs are announced every year, ranging from compact, unmanned geothermal "towers" that do not deplete geothermal energy (unlike the unwieldy manned structures),[27] to compact fluorescent and LED white lights, which can save the U.S. 31.7 billion kWh per year, the output from three or four nuclear power plants.[28]

Mills as Futurist: Why Bother to Plan?

When Mills says, "I have chosen not to engage in the question of whether it's 5% or 6% or 8%," he plays the philosopher—the futurist, who looks at the big picture, and does not concern himself with trivial details. He says we cannot predict the future. We cannot know what energy systems will be like in seventy years, so why speculate? For that matter, why plan at all? We should let things slide, let the market take care of things, and let our grandchildren clean up the mess. I agree that the hot fusion program overreaches. It is targeted fifty years ahead, and it has already slipped forty years. But Mills goes too far with laissez faire, and he contradicts himself a few pages later when he points out, correctly, that the systems we have now were invented decades ago. Serious research in nuclear power, coal gasification and solar cells began sixty years ago. Modern wind turbine research began thirty years ago. These technologies are just now reaching fruition, and it would be foolish to abandon them now or to stop long-range planning. We should not blunder from one energy crisis to the next.

Mills does have a point. If cold fusion succeeds, we will not need wind turbines, and if wind turbines continue to grow at the present rate, in twenty years we will not need pebble bed nuclear reactors, or coal for that matter. But at this stage it is prudent to fund research in all three: cold fusion, wind turbines, and fission. Mills has dredged up many interesting quotes from people who made grandiose predictions that did not work out, or predictions of disasters that did not materialize. He says—correctly—these people lacked vision, and they did not realize that alternative technologies were on the horizon. He himself is a good example of this, when he dismisses every alternative to fossil fuel.

Mills superficially agrees with some of the policies advocated in this magazine. But he gets the essence wrong. He overstates and over-generalizes. He casually dismisses statistics collected by the DOE, EPRI, and other mainstream organizations. The statistics are supplied by U.S. industry, which is generally run by competent and honest people. (Exceptions like Enron stand out because they are rare.) It is one thing to question authority regarding controversial, complex subjects such as global warming or energy tax policy. It is quite another to ignore a professional engineer who tells you how many watts his Internet router draws. Mills snidely denigrates the value of peer review in engineering studies of conventional energy, although oddly enough he assumes it is a "critically positive signal" in "fields of basic research." Why would it be different? Are engineers less objective than "basic researchers"? At this magazine we have often taken the opposite point of view: industry statistics are reliable, but peer review sometimes fails in physics, when it degenerates into censorship. However, in both engineering and physics, peer review is beneficial when it is done properly, according to academic traditions. Melvin Miles described how he wrote a critique of some early cold fusion papers: ". . .I studied each of the scientific papers involved very carefully to ensure that I would not misrepresent their results. Despite my efforts, the referees still found several examples where I made mistakes. This illustrates the central role of referees in this scientific process."[29]

Mills' own work demonstrates the vital importance of peer review, not to mention copy editing and fact checking. Anyone knowledgeable about energy could have reviewed this paper and shown Mills a dozen embarrassing technical errors. Leading experts from government and industry have contacted Mills about his mistakes, and they have testified in Congress to correct his testimony. He ignored them.

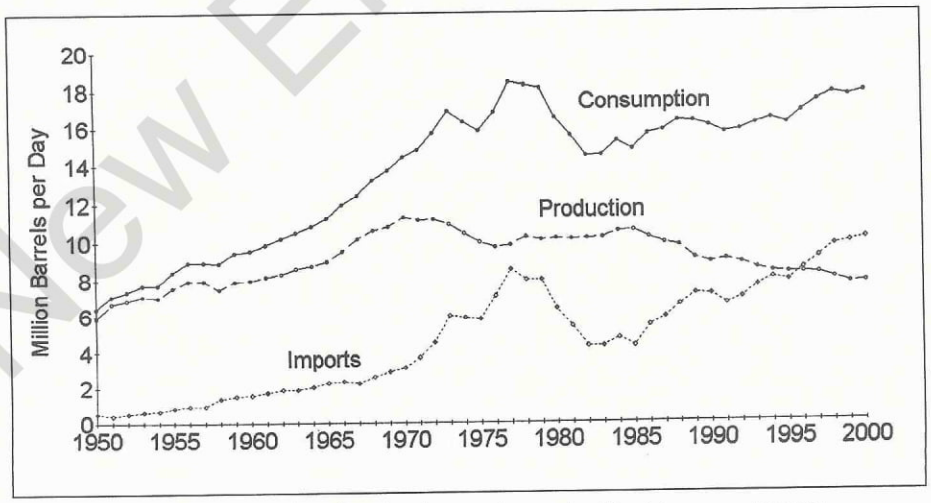

Figure 3. U.S. production of crude oil and natural gas plant liquids versus imports.

Why Mills Belittles Wind Power

Mills dismisses wind power because, he says, it presently meets less than 1% of our needs, and he claims it is "just not generally useful." He is ignoring trends, customer demand, and the lessons of history. In 1908, cars provided less than 1% of our transportation. The horse population continued to grow, peaking in 1929. Yet by 1935 cars dominated, even though they were still more expensive than horses. Customers were willing to pay extra because cars were faster, more comfortable, weatherproof, flexible, cleaner, and easier to

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use. The cost of cars fell rapidly. For a generation, production increased explosively, just as it did in the early days of computers, telephones, electricity, and other major innovations. The absolute number of cars in use in 1908 was no indication of future trends. Market conditions and the advantages of wind power are similar to those of cars in 1908. Worldwide, wind farms have 5,200 megawatts actual generator capacity, or 18,500 MW "nameplate" capacity. This is equivalent to five or six U.S. nuclear power plants. Wind power is growing at approximately 1,300 MW per year, equivalent to 1.4 nuclear plants. Denmark and some parts of Germany now derive 15% of their electricity from wind.[30]

Wind resources are effectively unlimited in the U.S., Europe, and China, where most energy is consumed. However, prime wind locations in the U.S. are in the Midwest and the Dakotas, distant from most population centers. The kilowatt-hour cost of wind power is roughly equal to the cost of coal, but it is cheaper when you take into account the cost of pollution. The equipment costs about $1,000 per kilowatt of capacity, compared to $500 for fossil fuel, and $3,000 for nuclear power (some estimates run as high as $6,000). Wind generator and maintenance costs will continue to fall as production ramps up. Costs are dropping much more quickly than fossil fuel and nuclear plants. For the past eight years, wind power has expanded 16% to 28% per year, averaging 23%. (Coal and oil increase 1% per year.) Automobiles and computers grew at similar rates for a generation. If wind continues to increase at 20%, by 2023 worldwide it will supply as much electricity as the U.S. presently consumes. By 2028 it will supply all of the world demand for electricity, and by 2034 it will meet present world demand for *all sources of energy*. In this scenario, hydrogen fuel cells would be used in transportation.

As a practical matter, it would not be sensible to replace all power generation with wind in only twenty-six years, when many hydroelectric, fossil fuel, and nuclear plants will still be in peak condition. Electricity direct from wind may only be economical for 20% to 30% of the U.S., because windy areas are far from most cities and electricity is difficult to transmit over long distances. This drawback might be overcome with high temperature superconducting transmission lines and dispatchable hydrogen fuel cells. Japan and some other major nations have few wind resources. To make up for this, hydrogen could be produced in the U.S. and China, and transported the way liquefied natural gas (LNG) is today. In thirty years, the U.S. could replace OPEC.

Even if wind power were limited to supplying 20% of electricity, it would greatly reduce the use of coal, which generates about half of our electricity. Coal plants pollute more than natural gas and nuclear fission plants, and they are generally the oldest and closest to retirement. As coal plants wear out, they will be replaced by wind, unless Mills and other industry flacks can persuade Congress to tilt the playing field more drastically in favor of fossil fuel. Cold fusion has all of the advantages of wind power, plus many others. If Mills knew cold fusion is real, he would probably fight it as vigorously as he fights wind energy. But there is no evidence in any of Mills writings, including his recent report,[31] that he knows anything about the status of cold fusion. He has simply bought into "establishment" ways and ignored it.

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30. The figure often published is 18,500 MW installed, and 5,200 MW per year expansion. This is the "nameplate" or full-load output. Actual average output is lower because wind is variable. It is 23% of nameplate power in Germany, 26% in Denmark, and 34% in windy places like Wales, the North Sea, and North Dakota. I used 28% here. Nameplate capacity for the average U.S. nuclear plant is 1,013 MW, and actual output is quoted ranging from 88% to 94%, or roughly 920 MW. It is not 100% because the plants have to be shut down for refueling and maintenance. Source: Danish Wind Industry Association, http://www.windpower.dk/core.htm, Existing Capacity and Planned Capacity Additions at U.S. Electric Utilities by Energy Source, 1999, Energy Information Administration, DOE.
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The Ninth International Conference on Cold Fusion (ICCF9)

International Convention Center
Tsinghua University
Beijing, China
May 19–24, 2002

The study of Cold Fusion (CF) phenomena, sometimes referred to as "New Hydrogen Energy" (NHE) is progressing in numerous laboratories all around the world. More than ten years old, the field is enjoying ever more reproducible experiments and better interactions with the scientific community. A large variety of experimental approaches will be addressed at the Conference, together with theoretical attempts to interpret the observed phenomena.

The important sponsorships that have been secured for ICCF9 (Fundamental Research Division, Ministry of Science and Technology Physics Division II, Natural Science Foundation of China, Chinese Nuclear Physics Society, Department of Physics, Tsinghua University) guarantee that the Conference will maintain the most rigorous scientific standards. As stated in Lerici at ICCF8, the theme of ICCF9 will be coherence: Coherence between Nuclear Physics and Solid State Physics; Coherence between Cold Fusion and Hot Fusion; Coherence between Research and Development. We are glad to see the progress in all three aspects in the past years.

The following are some topics that will be covered at ICCF9: heat and related products; nuclear processes and transmutations; materials; innovative approaches; and theories.

The Conference will consist of oral and poster presentations. The official language of the Conference will be English.

Pre-registration, registration, and submission of abstracts should preferably be performed using the Conference website, which will be updated regularly, and will provide all necessary information and interactive procedures. Those who do not have access to the Internet are kindly requested to contact any one of the Conference Secretariats.

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Paramahamsa Tewari
Vinodini Nivas
P.O. Gotegali 581 317
Karwar, Karnataka, India
Website: http://www.tewari.org

Infinite Energy received the following report from Paramahamsa Tewari in India—forwarded by Mr. Toby Grotz:

Tewari Space Power Generator Test Results 1/28/02

The latest SPG tests have shown over-unity operation. Electrical input of 8.6 kW to a motor-generator set (DM-SPG), produced 11.7 kW of electrical power output, in addition to 3.1 kW dissipated due to windage and friction (all voltages and currents are DC, direct current).

The energy balance: From 8.6 kW input, the output is: 11.7 + 3.1 = 14.8 kW. This is due to violation of Lenz's law, and has implications for the violation of the law of the conservation of energy (LCE). [*Ed. Note*: More properly, "apparent" violation of the LCE.]

As per my conclusion: The LCE is not violated in thermodynamics, but violated in electrodynamics. My experimental results show that a major violation of Lenz's law is possible, which enables highly efficient machines (DM-SPG) that will lead to self running systems.

The validity of a new theory depends upon its ability to explain and to obtain quantitative results for the phenomena remaining unresolved by contemporary theories (CT). The Space Vortex Theory (SVT) addressees and explains the following:

1. The surface gravity of Earth (also, of other planets, and Sun) has been derived with the principles of the SVT in quantitative terms with a new relationship, after deriving Kepler's law (solar space vortex), and using the orbital speed of the moon, its distance from Earth, and Earth's radius (Paper 1, www.tewari.org). So far, surface gravity is only experimentally measured.

2. New equations presented in the SVT allow the derivation of the orbital radii of planets using: electrical repulsive forces between the Sun and the planets (a hitherto unknown force in celestial mechanics), mass of the planets, and the orbital speeds of the planets (being published in my book, *Cosmic Principles of Space and Matter*).

3. The electron's mass and electron charge, applicable for particles, planets, stars, and galaxy are formulated in the SVT by way of new equations. All known universal constants are theoretically derived, and it is shown that the speed of light is a common factor in all (Paper 1, www.tewari.org).

4. The continuing creation of cosmic matter at the galactic center is predicted by SVT (Paper 2, www.tewari.org).

5. It is concluded that the electron has, at its center, a discontinuity of energy distribution, which reverses the direction of all fields from outward to inward, and makes the modern concept of space and matter diametrically opposed to reality.

6. Misconceptions about the nature of light leading to mathematical errors in quantum physics (Paper 3, www.tewari.org).

If contemporary physics (classical, relativistic, quantum) can provide solutions to even the first two of the above, I would accept that the SVT is not only superfluous but a nonsensical philosophy.

V.V. Roshchin and S.M. Godin
Institute for High Temperatures
Moscow Academy of Science
E-mail: rochtin@mail.ru; smgodin@online.ru

Abstract of a Presentation at the New Hydrogen Technologies and Space Drives Conference (June 23/24, 2001):

"Generator with Energy Conversion and Anti-Gravity Effects" (An Experimental Investigation of the Physical Effects in a Dynamic Magnetic System)

We have experimentally studied the physical effects in a system based on rotating permanent magnets. It is demonstrated that a magnetic system made of rare-earth magnets (REMs) is capable of converting various forms of energy, provided that a certain critical operating regime is set.

The generator comprises an immobile stator and a rotor moving around the stator and carrying fixed magnetic rollers. The magnetic system of the working body of the generator has a diameter of about 1 m. The stator and magnetic rollers were manufactured from separate magnetized segments made of REMs with a residual magnetization of 0.85 T, a coercive force of [Hc] ~ 600 kA/m and a specific magnetic energy of [W] ~ 150 J/m^3. The stator incorporated REMs with a total weight of 110 kg and the rollers contained 115 kg of the same REM material.

On attaining the critical regime (550 rpm), the rotor exhibited a sharp increase in the rotation speed; this was accompanied by a slow-down in the rate of the current weight variation. The system weight variations depend both on the power consumed by the active load and on the polarization voltage applied. For a maximum output power (7 kw) a change in the total platform weight reached 35% of the initial value in the immobile state (350 kg). The platform weight could be controlled by applying a high-voltage signal to the cellular ring electrodes situated 10 mm above the external roller surface. The effect of the system weight variation is reversible with respect to the direction of rotor motion and exhibits hysteresis within 50-60 rpm.

Besides the phenomena described above, a number of other interesting effects were observed in the system studied. In particular, the generation operation in the dark is accompanied by a corona discharge with a pink-blue light emission and by the production of ozone.

One more effect, which was never reported previously, is the appearance of vertical "magnetic walls" around the generator. The measurements revealed zones of increased magnetic field strength on the order of 0.05 T arranged coaxially relative to the system center. The layers of increased magnetic field strength are propagating with virtually no attenuation to a distance of 15 meters from the converter center and then rapidly decayed at the boundary of this 15 meter area. Each layer zone is 5-8 cm thick and exhibits sharp

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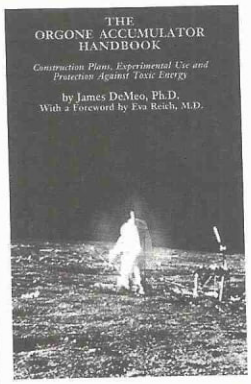
boundaries; the layers are spaced by 50-60 cm.

Another interesting phenomenon consists in an anomalous temperature drop in the immediate vicinity of the generator. At a general room temperature level in the laboratory (+22 +/- 2°C), the temperature at the generator surface was 6-8°C lower. Similar temperature variations were detected in the vertical "magnetic walls." The same pattern was observed at a height of 5 meters above the setup in a second-floor room above the laboratory (despite the steel-reinforced concrete blocks separating the rooms).

Roshchin and Godin have a Russian patent (No. 2155435, application dated October 27, 1999) "System for Production of Mechanical Energy and Method of Production of Mechanical Energy."

The Orgone Accumulator Handbook



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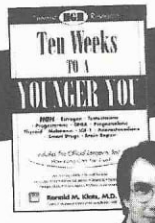

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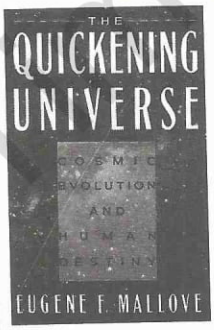

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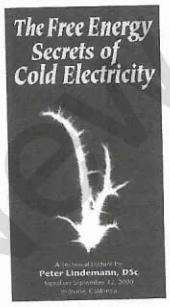

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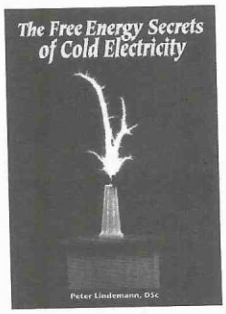
The book **is a wonderful companion to the video. Covers the same material, but goes beyond the video in its publication of text and graphics, making it possible to do detailed study. Appendices include patents by Edwin Grey and Nikola Tesla, as well as two excellent articles by Dr. Lindemann.**



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Testing Update

NEW ENERGY **Research Laboratory**

Ken Rauen

Sonofusion

Roger Stringham's sonically activated hydrogen fusion process has been the primary focus of NERL's replication efforts over the last year. We acquired one of Roger's devices, have tested it, and have modified its design with the intention of commercializing it and making it easier to operate. *IE* issues over the last year have covered this activity. Some excess heat has been measured, but less than Roger measured and with nowhere near the repeatability which he found. We are not comfortable with the poor repeatability, so we say that we have not replicated the effect. Previous announcements of positive test results should not be taken as statements of replication. Some tests were later discovered to be flawed, after the publication deadline was exceeded, and the others just did not produce the same results when we repeated them. In retrospect over the last year's efforts, it is best to say that sonofusion has not been replicated at NERL.

We now see that our sonofusion replication project has given way to pure research on the phenomenon. Roger's ideas have not worked and we are trying our own ideas to make it work with a more practical device. The sonofusion process is not in question, as we think the helium detection, transmutation, and microvolcanic evidence in the host metals, which were documented by other labs, are legitimate and solid evidence that sonofusion is real.

With a close eye on the performance of our ultrasonic wattmeters in our test apparatus, and with greater understanding of our volunteer instrument maker, Chris Eddy of Pioneer Microsystems, we have decided to redesign our ultrasonic oscillator and reactor interface and power monitoring point in the circuit. The wattmeters monitor the instantaneous voltage and current to the sonofusion reactor for real-time, analog, high speed V-I multiplication. The initial ultrasonic wattmeter design accommodated the circuit interface established by Crest, the manufacturer of the oscillator and piezoelectric transducers we are using. Crest mounts inductors in series with the piezo elements as a method of achieving high voltages across the piezos. The series resonance of the inductors and piezos produces a much higher voltage across the piezos than what is applied to this LRC circuit from the oscillator. The inductor-piezo interface is what was readily available to us to connect our wattmeters, as the inductors are mounted on the printed circuit board and external wiring connects the circuit board to the piezos. This created numerous problems, which turned out to be too difficult to overcome.

Chris suggested that we remove the Crest inductors from the Crest oscillator circuit boards and mount them on the reactor. There are several advantages to doing this. Primarily, the voltage and current multiplication will be easier, as the signals will be nearly in phase before the inductors. Secondly, a large voltage divider is no longer necessary to get a proper signal to the integrated circuit inputs; the large voltage divider (1:250) was plagued with reactance problems, as resistors are not pure enough resistances for accurate operation of these meters. Thirdly, dangerous voltages are more isolated on our test bench; 3 kV peaks with 1 amp capability is more than deadly—it can also start fires, and it has. One BNC bulkhead fitting with a plastic insulator caught fire when the insulation broke down and arced. Now the high voltage wiring will be limited to a span of about 5 cm from an inductor to a piezo element. The wiring between the reactor and the oscillator will now be reduced to a mere 350 V peak.

Chris has taken back a pair of wattmeters for modification. In the meantime, I have taken the opportunity to examine a potential factor for identifying nuclear fusion. Roger Stringham often produced visible deterioration of his exposed targets. A recent run by me with light water, protium oxide, produced no visible erosion of the exposed

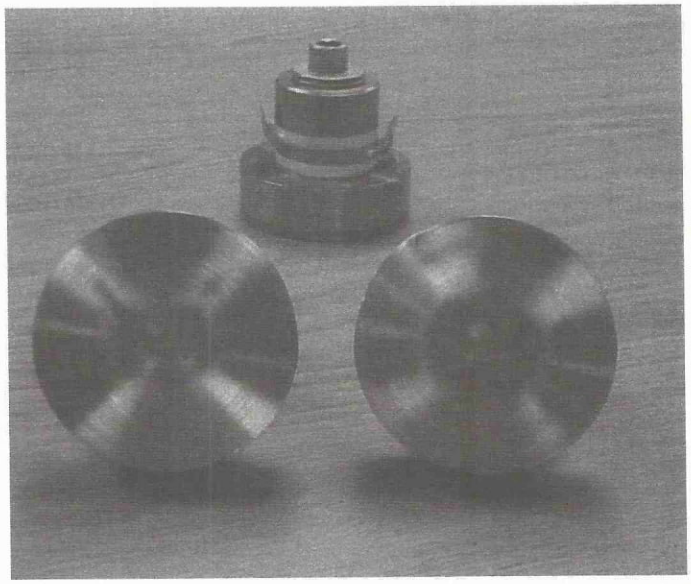

Photo 1. Two piezoelectric transducer stacks are seen here with the titanium faces shown. These were exposed to protium oxide, light water, for 19 days under ultrasonic agitation. Note the dull appearance of the eroded areas. In the background is a third transducer stack, showing its detail.

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titanium surfaces. Could this be an indication that fusion was not occurring? None of our protium oxide runs over the last year produced any significant excess heat, and I did not notice erosion from those tests. Titanium is a hard metal and might not be eroded by ultrasonic energy alone. So I tested my hypothesis by exposing a pair of titanium-faced piezo stacks to protium oxide for 19 days, the same duration as a known pair of transducers which were eroded and exposed to deuterium oxide, heavy water. After 19 days, the light water did erode the titanium. Heat measurements were not made, as the wattmeters were out of commission. All that can be concluded from this test is that there is no difference between heavy water and light water for its visual effects on titanium. If there were a difference, we would investigate further. Our difficult and inconclusive observations of excess heat could benefit from another indicator of cold fusion occurring. We will keep looking. The titanium erosion may be due to the formation of titanium hydride, a stable and insoluble compound.

We have purchased a highly stable signal generator, a Hewlett-Packard HP-33120A, and a spectrum analyzer, a Link Instruments DSO-2102M. These instruments will allow us to match impedance curves of each piezo transducer just in case this is important for proper system operation. It could be that Roger Stringham found consistently positive results because he had fortuitously matched transducers. He used the same ones for years, and this could be the reason for his observed high repeatability.

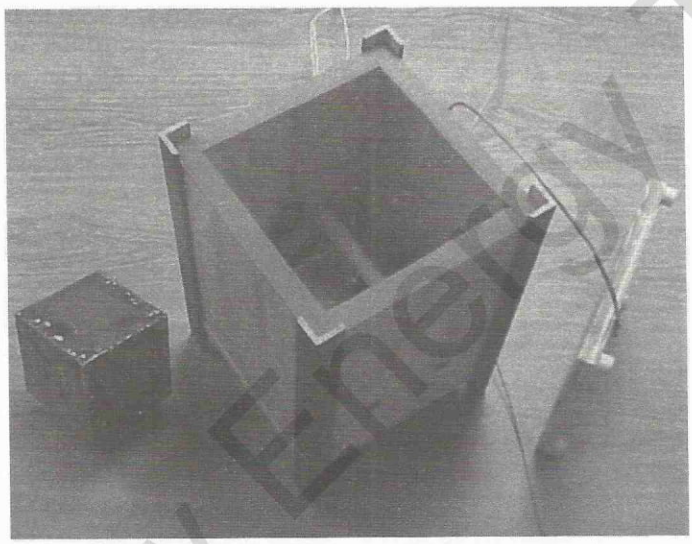

Photo 2. The copper cube and wooden SEC. The SEC is open and its lid is resting on the table, on edge. The thermocouple wires are too fine to be seen in this photograph. The TC junctions are spaced 1" apart in a rectangular pattern and cover all surfaces of the SEC base and lid, inside and out, and the TC wires penetrate the plywood. There are two wooden dowels across the two side walls which create a mounting platform for the cube, originally intended to cradle our sonofusion reactor. A circulation fan and a bank of resistor heaters are mounted inside, below the dowels; they were not connected during the testing of the copper cube. The resistors and fan were used to calibrate the SEC. Its sensitivity is 0.00320 volts per watt.

A Modified Reich-Einstein Experiment

Since the Correa's replication of the Reich-Einstein experiment (see *IE* #37) and the demonstration of heat flow from a Faraday cage by the attachment of a sensitive Stirling engine, we decided to try to measure the heat flow by another method. A Faraday cage is a metal enclosure which blocks electric fields and is highly effective for eliminating electromagnetic radiation, such as radio waves. A wooden Seebeck envelope calorimeter (SEC) was built while we awaited the delivery of a commercially available SEC from Thermonetics for use on our second sonofusion test bench. Now that sonofusion testing is temporarily halted, the wooden SEC is available for use. We decided to test a Faraday cage inside it. The homemade SEC is well-suited to this test, as it is not shielded or grounded. It is constructed of plywood, with approximately 600 loosely spaced, soldered copper-constantan thermocouple junctions. A copper Faraday cage was made from three 8" x 4" x 0.025" copper plates, bent in half as "L" shapes and soldered.

Our laboratory has produced notably small temperature differentials in the Reich-Einstein experiment. This may be because of the metal roofing of our building acting as a shield, as a partial Faraday cage. See IE Nos. 37 and 41 to compare our temperature differentials with those measured by the Correas. The effect manifested not as strongly here—and under the particular conditions of our testing.

Knowing this handicap, we have begun experiments aimed at measuring a heat flow from the copper cube with the wooden SEC. Without resorting to statistical evaluation of the datalogger data file, we saw no heat released over nearly a week, while weather patterns changed. The visible noise floor for the graphically presented data is less than 50 mW. We do not know how much shielding the thermocouple coverage around the SEC is producing, as metal screen is often used effectively for Faraday cages. We may be inadvertently diminishing the effect by the presence of the totally surrounding thermocouple wires.

The test apparatus will be moved off-site to a location where there is a stable thermal environment and little metal to alter the aether energy fluxes which Reich, the Correas, and others have measured. We will report the results of this in a future issue. ❑❑❑

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A Modified Orgone Accumulator (Complete HYBORAC) as a Nighttime Drive for a Low Delta-T Stirling Engine

PART II

Paulo N. Correa and Alexandra N. Correa*

Abstract

In a previous report,[1] the first of a two-part series, we demonstrated that it was possible to drive low delta-T Stirling engines of the MM6 type from the solar-sourced anomalous To-T difference registered in modified Orgone Accumulators referred to as HYBORACs, composed partly of a matte black-painted ORAC and partly of a Faraday cage. The design optimized response to solar radiation as well as heat retention, yielding motor speeds up to 140 rpm with ΔT's on the order of 21°C. In the present report, our focus lies in maximizing the HYBORAC structure so that it can sustain outdoor operation not just when exposed directly to atmosphere-filtered solar radiation, but above all during the nighttime hours when the device cools together with the cooling air and in the absence of solar radiation. It should be noted that this is not simply a problem of maintaining a positive temperature difference (To-T), since the motor action continually pumps sensible heat out from the HYBORAC. But by increasing the retention of heat, we can also maximize utilization of the sensible heat being generated from other energy conversions occurring inside ORACs.

The solution lay in an arrangement that employs both the HYBORAC and inverted BORACs as components of a more traditional ORAC arrangement, into which they can be inserted. With this improved combination—referred to as the "complete HYBORAC"—we were able to achieve speeds of 150 rpm during daytime (with ΔT values reaching 22.5°C), and speeds of 30 to 80 rpm during nighttime (with ΔT values of 3.1 to 9°C). Maximum nighttime duration of Stirling Motor operation with the complete HYBORAC was 399 minutes (nearly seven hours), frost effectively bringing the motor to a halt even in the presence of a suitable ΔT value (3.5°C). Typical performances extended up to 15.5 hours of continuous Stirling motor action. The To-T values measured at the top plate of the HYBORAC reached 32°C during daytime, with ΔT recovery efficiencies of 65 to 86%, whereas nighttime To-T values exceeded ΔT by no more than 2°C, and when they became smaller than the ΔT (with recovery efficiencies greater than 100%), the motor began to exhaust heat generation inside the complete HYBORAC. From that point until it stopped, nearly two hours elapsed.

Introduction

Driven from solar radiation by an influx of sensible heat, the HYBORAC/Stirling coupling is condemned from the outset to form a non-analytical arrangement destined to be of substantial interest if it can be developed into a power generation device that works not just during daytime, when it is exposed directly to the Sun, so to speak, but also during nighttime, in the absence of direct solar radiation. The HYBORAC design we have previously proposed optimizes the drive coupling for daytime operation—under direct exposure to solar radiation—but, a different arrangement was necessary for nighttime operation. This effectively led to a new modular design of the HYBORAC—as consisting of a matte-black Faraday cage filled with basalt fiberglass, with the three BORAC sides forming a separate removable platform. During daytime, the BORAC platform was assembled together with the black cage; at night it was inserted inside another special ORAC design, to form the complete HYBORAC. After further thought and functional experimentation, the nighttime ORAC container (NORAC) (see Figure 10) became composed of an outer rigid structure wrapped in wool on the sides and the bottom, containing a fixed inert plastic box, into which was inserted another matte black inverted BORAC (12" x 12" x 12"). This inverted BORAC contained a 4 inch thick inner basalt fiberglass 8" x 8" x 8" cavity into which the matte black cage of the HYBORAC could be easily inserted. The thought behind this arrangement is that, at a time most suitable for insertion, the HYBORAC arrangement would be quickly disassembled, with the matte-black Faraday cage being immediately inserted inside the inverted BORAC, which, in turn, would be inserted inside the wool-lined plastic cage of the complete HYBORAC. This effectively assembled, for nighttime performance, a 2x ORAC, with each of the inverted BORACs (the large 12" x 12" x 12" box and the 8" x 8" x 8" box) forming one of the metal layers of the ORAC. The complete arrangement was covered by an R6 styrofoam top with a central opening through which the Stirling can be inserted to directly contact the black cage. The large inverted BORAC could also be used to drive a second Stirling motor during daytime, or instead be used as the bottom plate of the daytime HYBORAC arrangement, contributing to greater performance of the motor, and at nighttime be withdrawn into the complete HYBORAC structure, to keep the Stirling motor action on.

The following communication reports on the performance results of just such an apparatus. With it, we were able to achieve ΔT's on the order of 15 to 25°C throughout daytime (with To-T values for the top plate of the HYBORAC on the order of 20 to 30°C) and to run MM6 models up to 150 rpm, in the cool autumn days of a northern temperate climate known for its relative lack of sunlight, and to run the same Stirling motors well into the night, up to nearly seven hours of continuous operation—at speeds of 25 to 60 rpm—for total periods of operation up to 14 hours or more.

Methods and Materials

Following the initial experiments reported in our previous communication on this topic,[1] Dr. Eugene Mallove provided the authors with another pair of MM6 Stirling motors so that we could conduct parallel or simultaneous controls—greatly improving our chances of making accurate compar-

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isons with experiments that, in general, depend on the "whims" of changing weather. Unfortunately the two new motors, MM6-2 and MM6-3, though capable of outperforming the specifications of the manufacturer, did not have the exact same physical characteristics, with the former starting up at 3.2°C and running with ΔT's as low as 2.2°C, and the latter starting up with 2.8°C, running with as little as 1.6°C, and, for all ΔT values, giving in general 6 to 10% faster speeds of rotation. Mounted in the HYBORAC with ΔT's of 16 to 18°C, the third motor was consistently faster by 17 to 19% over the second one. Rather than exacting simultaneous comparisons between different arrangements, the authors opted instead to study how to sustain motor action into the nighttime periods.

Several test runs were conducted in the course of experimenting with the design of the complete HYBORAC, until a satisfactory design emerged. As described in the previous section, two inverted BORAC boxes were constructed, with the larger box having a cavity for insertion of the smaller one, and also fitting within the plastic receptacle of the NORAC (see Figure 10).

Results

The following test began at 08:30 a.m. on November 17, 2001, when the apparatus was brought out from outdoor storage and mounted on a glass table. The 8" x 8" x 8" inverted BORAC was assembled in the HYBORAC configuration with the MM6-3 mounted on top, and the 12" x 12" x 12" inverted BORAC was turned upside down, with the MM6-2 mounted on it. For purposes of our experiment, we were only interested in the performance of the MM6-3 mounted on the HYBORAC proper. In the early part of the day we tested both motors on the HYBORAC, with the MM6-2 reaching speeds of 97 rpm, with ΔT values of 20.5°C, whereas the MM6-3, with lower ΔT values reaching 18°C, ran faster, at 112 rpm. By 10:00 the sky was covered by haze and some diffuse cloud cover which cleared up by 11:30. The MM6-3, however, continued to run. The recorded experiment began at 13:00. Performance is shown in Figure 1, where motor rpm is compared to both ΔT and To-T values, the latter being expressed solely for the top plate of the 8" x 8" x 8" black cage proper.

Motor response peaked at 14:00, clocking 147 rpm when To-T reached 33°C and the ΔT had just come off its highest point of 22.3°C, having taken ca 1 hour to reach the peak, from the 108 rpm clocked near 13:00. The percentage efficiency of ΔT as a function of To-T at this peak speed was merely 66.3%. From this peak, and as a function of solar radiation, the motor rpm decreased steadily, until the ΔT was 15.5°C and To-T at 22.15°C (85.5% recovery efficiency). This occurred at 15:36, at which point the black cage proper was removed from the HYBORAC panels and promptly inserted inside the larger inverted BORAC, which in turn was inserted inside the NORAC plastic receptacle. The drawback of this action is, of course, the act of removing the MM6-3 from the top surface of the black cage—since this must be done so that the top of the NORAC is put in place, the MM6-3 then being lowered until it again contacts the top surface of the black cage, now fully inserted into the complete HYBORAC arrangement. This action inevitably cools down both the bottom of the Stirling motor and the top (and backsides) of the black cage. In the experiment shown, it caused a drop of the ΔT from 15.5°C to 9°C, concomitant with a drop in To-T, from 22.15°C to 11.65°C.

Practically, as of 15:57, the entire arrangement was no longer directly exposed to solar radiation, even though the sunset occurred later, at 16:49 EST. By 18:06 signs of water condensation were visible over all the exposed top surfaces of the apparatus, and by 18:45 frost became discernible. DWLS analysis of the correlation of ΔT with motor rpm (Figure 2) suggests distinct daytime and nighttime functions, the former—for a bright sunny day—likely dependent entirely upon solar radiation, its angle and intensity, and the latter dependent upon both the local rate of atmospheric cooling (and thus local weather) and the rate of heat generation by terrestrial ambipolar radiation drawn in by the complete HYBORAC device.

As shown in Figure 3, visible condensation occurred near 80% RH, with frost forming at 85%, and the motor coming to a stop as a function of increased friction caused by frost at 92% RH. It is noteworthy that the inversion of ΔT and To-T occurred at 90% RH. Also shown in Figure 3 is the time course for the ambient air temperature—which peaked at 9.5°C, near 14:00. The time chosen (15:37, as shown by the dip of the closed square curve) for insertion of the black cage into the complete HYBORAC coincided with the time when the air temperature precipitously dropped from 9°C to 5°C in just a half-hour (as shown by the open square curve). This was a good estimate of when to proceed to the change between the daytime and nighttime configurations of the HYBORAC. It is also apparent from Figure 3 how the motor came to a stop when ΔT reached 3.1°C and the air temperature -1°C.

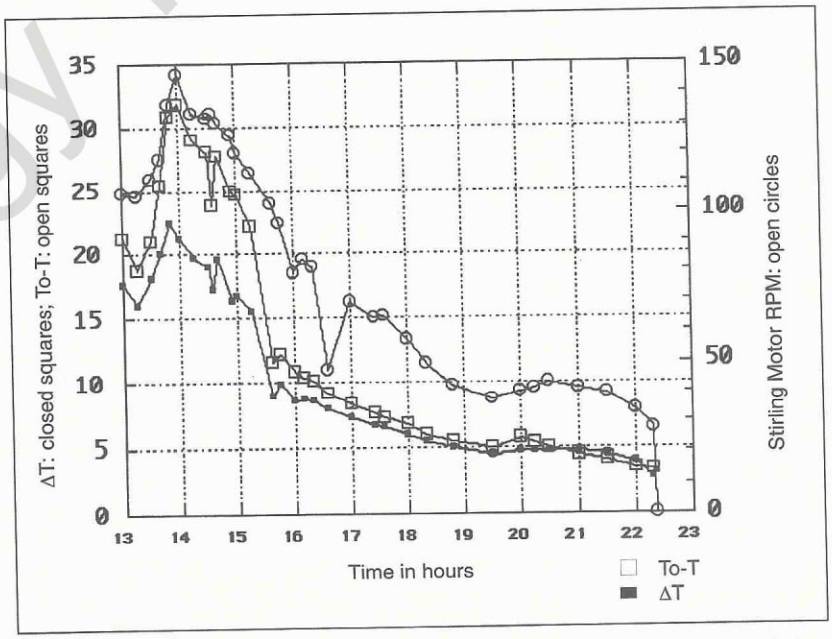

Figure 1. Time course of the complete HYBORAC experiment. Insertion of the black cage into the complete HYBORAC took place at 15:36 EST. This is reflected by the drop observed in motor speed near 16:00. As of the same approximate time, the Sun disappeared behind trees and buildings, with the actual sunset occurring at 16:49. By 18:00, condensation was observed on all of the exposed surfaces and by 18:45, frost began forming on the MM6-3 surfaces. Inversion of ΔT and To-T is observed at ca 20:40, with the motor action going on for at least another two hours before stopping.

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The dependency of motor speed upon air temperature and the presence of solar radiation is highlighted by Figure 4, where again we encounter two distinct slopes for the daytime and nighttime correlations. The lesser rise of the daytime curve indicates stable dependency upon direct solar radiation, whereas the steeper rise of the nighttime curve indicates to which extent it is a function of the cooling of the local atmosphere. This dual daytime/nighttime slope effect is also exemplified by the correlation of ΔT with To-T, as shown in Figure 5, where the steeper nighttime slope gives nearly 1:1 correspondence, or even efficiencies that are greater than 100%, and the daytime slope indicates rates of ΔT recovery on the order of 65 to 86%. Since we have not proceeded to an examination of solar luminance, this two-fold correlation must be indirectly carried out by looking into the apparent phenomenological dependency of ΔT upon atmospheric ambient temperature, as shown in Figure 6. The analysis suggests that nighttime devices capable of sustaining ΔT's on the order of 3 to 3.5°C should be attainable, even at subzero temperatures, which are at the limit of sustaining Stirling motor action—were it not for the effect of frost upon the motor.

A phenomenological correlation parallel, but inverse, to that of air temperature can be extracted from the humidity data, as shown in Figure 7, where the two-slope correlation is made even starker: the daytime variation in ΔT and To-T, which is parallel, appears to be essentially independent of relative humidity save for its coexistence with the lowest diurnal %RH values—which emphasizes the dependency of the daytime slope upon solar radiation. (This phenomenon brings to mind the dependency of the antigravitokinetic regenerative phenomenon we have previously identified, upon solar radiation.) During the night-

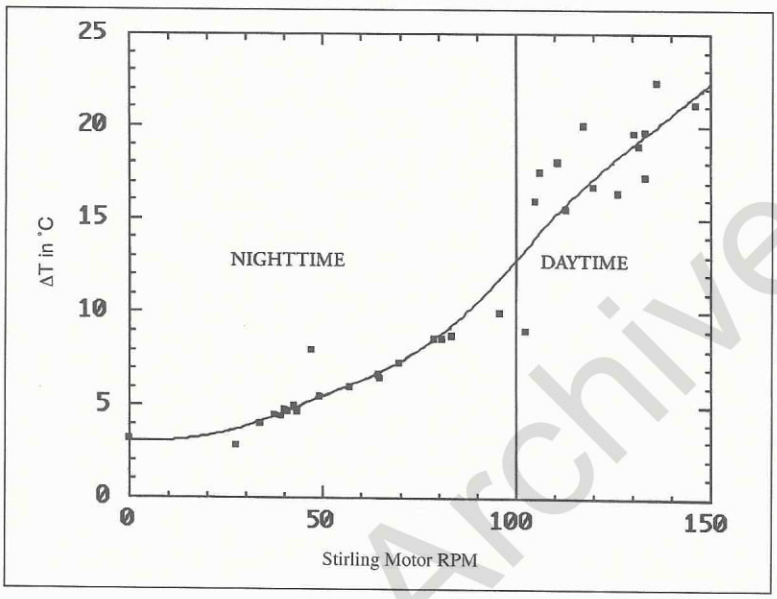

Figure 2. A two-slope function is suggested by DWLS analysis of the relation between ΔT and rpm for the MM6-3, when daytime and nighttime periods are considered. Daytime correlation depends upon the intensity of solar radiation, whereas nighttime correlation of motor speed with increasing ΔT depends both upon the rate of local cooling and the rate of heat generation by terrestrial ambipolar radiation drawn into the HYBORAC device.

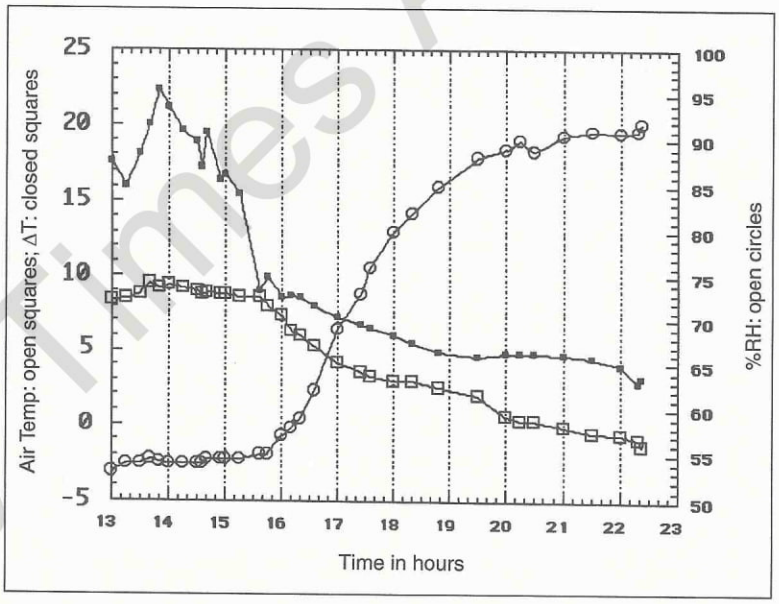

Figure 3. Time course of ΔT (closed squares, left ordinate), open air temperature (open squares, left ordinate) and percent relative humidity (open circles, right ordinate) for the outdoor November 17 test run with the complete HYBORAC.

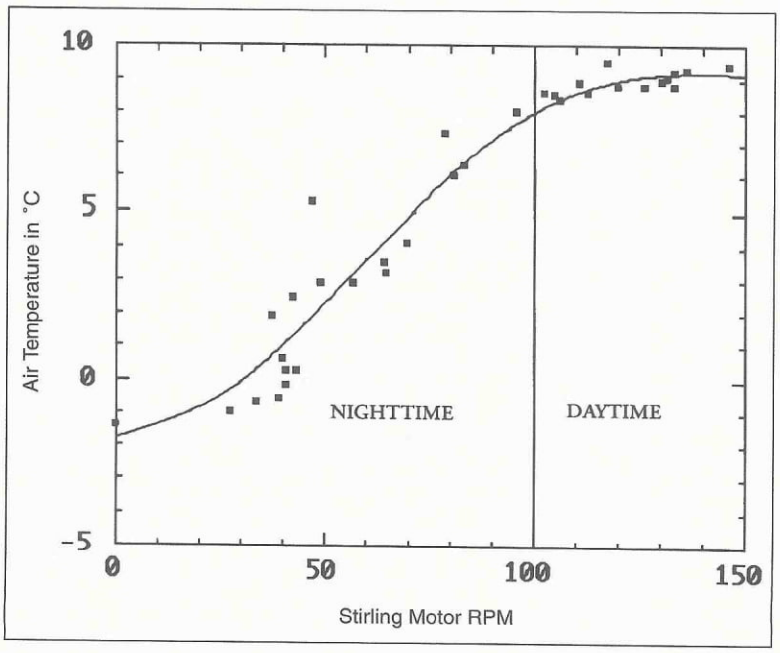

Figure 4. Dual-slope correlation of motor speed with air temperature, with speeds greater than 100 rpm depending directly upon solar radiation, and speeds below it being a function of the ambient cooling of the atmosphere, frost formation caused by saturation and condensation of water vapor, and the capacity of the complete HYBORAC in replenishing the heat pumped out by the MM6-3.

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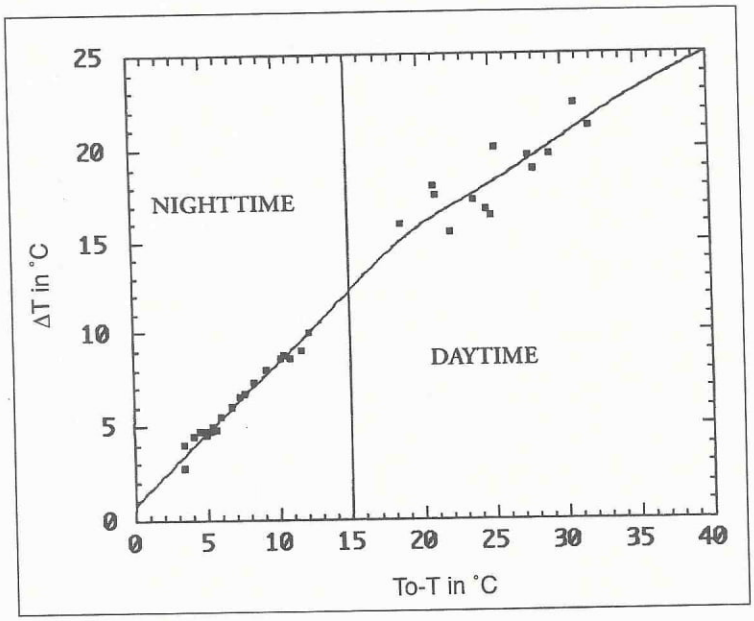

Figure 5. Dual slope correlation between ΔT and To-T for the top surface of the HYBORAC. Only the nighttime slope yields a near 1:1 correspondence, with the daytime ΔT recovery efficiencies being <86%.

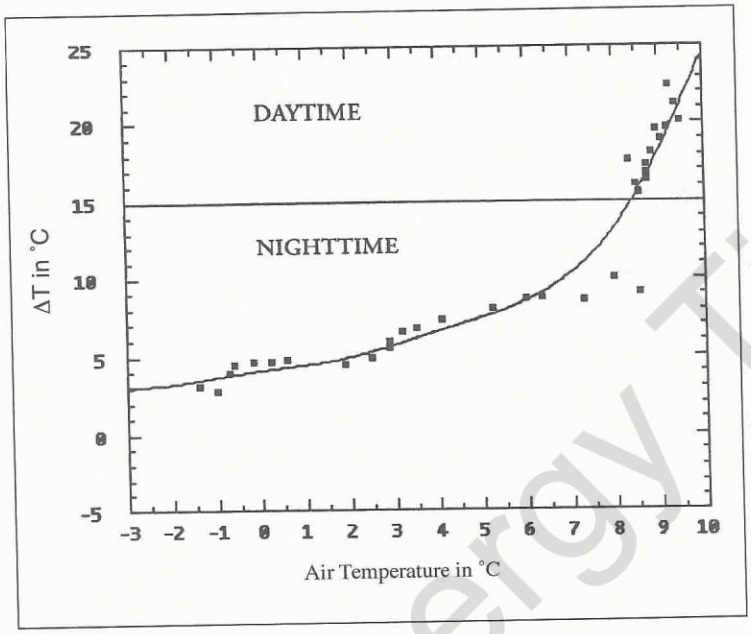

Figure 6. Dual slope phenomenological dependency of ΔT upon air temperature for daytime and nighttime. The nighttime slope suggests that the minimum ΔT required to sustain Stirling motor action can be held even at subzero temperatures.

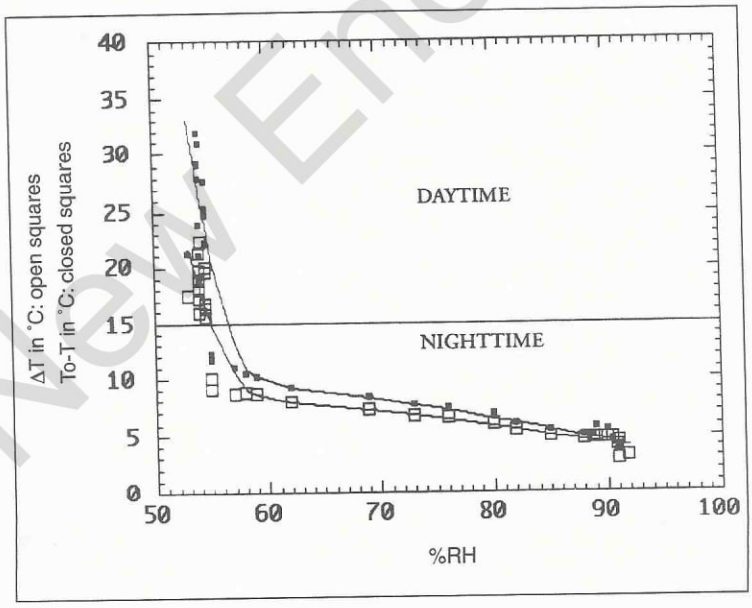

Figure 7. Dual slope of parallel curves for ΔT and To-T, as correlated to %RH. In the daytime portion of the curves, the excess thermal energy is essentially independent of humidity but correlated to its lowest values. High values of %RH, on the order of 90% or greater, correlate with a sudden drop in both curves and the loss of the temperature difference required to drive the Stirling MM6-3. This corresponds to the observed ice formation.

time, however, both curves fall towards a positive value of 5°C, and drop precipitously to 3°C when To-T<ΔT, the motor pumping out more heat than the device can generate.

This set of relations between ΔT, To-T, and motor rpm is synthetically presented in Figure 8, with ΔT recovery efficiencies of <86% being characteristic of daytime motor speeds >100 rpm, and efficiencies of >80% being characteristic of nighttime performance.

The superiority of the complete HYBORAC design is well-illustrated by the results of Figure 9, where its performance is compared to that of other arrangements. All tested apparatuses were exposed to solar radiation throughout the day. Time zero was 15:57, when the Sun disappeared behind the urban horizon and no more solar radiation was directly incident upon the test arrangements. The time it took to come to a stop for the same Stirling motor placed atop each of the arrangements was then compared. We did not control for windspeed, save to note that in all the tests, the time course coincided with that time of the day when wind effectively abated—and in no case, save for the test of arrangement 5, was wind speed greater than 9 km/h (19 km/hr was the windspeed on the evening of November 17). As shown in Figure 9, the apparatus with least energy retention was the reflective 8″ x 8″ x 8″ Faraday cage (arrangement 2), taking just 5.5 minutes to bring the Stirling motor to a stop. The 1x ORAC (10″ x 10″ x 10″ pine box, 8″ x 8″ x 8″ inch inner cage) tested in the previous report[1] lasted five times longer (arrangement 1, Figure 9). But this is easily outdone—by more than two-fold—by the daytime configuration of the HYBORAC itself (arrangement 3), which performed for 68 minutes after removal of direct solar radiation. We had previously constructed a three face 4″ thick

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cork cover for the HYBORAC, through the top of which the Stirling motor could be inserted back as soon as the Sun disappeared over the horizon. We now tested this arrangement (as number 4 in Figure 9), which extended the performance of the daytime HYBORAC by another 19 minutes (from 68 to 87 minutes).

When all these arrangements are compared to the present test arrangement of the complete HYBORAC (shown as number 5 on Figure 9), its superior performance becomes evident—and even more so if we keep in mind that the motor action came to a stop because of frosting ice forming in the moving parts, and not because the ΔT was no longer of a magnitude suitable to move the motor. For 6h 39 min, the complete HYBORAC performed continuously, outputting decreasing speeds from 103 to 28 rpm and, as shown in Figure 1, presenting four distinct regions of discrete acceleration after 16:00. As the HYBORAC had been working virtually constantly since 08:45, the overall performance approached 14 hours of "free"-work.

In preliminary experiments, while the NORAC box details were being worked on, we observed—with earlier versions of the complete HYBORAC—similar nighttime stoppages due to frost formation on the exposed components of the motor. During one experiment (November 12), frost began forming by ca 20:00, and within half an hour the motor had stopped, the ΔT having fallen to 2.9°C. We waited 13 minutes, and were able to restart it with a ΔT of 4.4°C, and to run with speeds of 37.5 to 27.3 rpm for the next 17 minutes, when it again stopped as ΔT fell to 3.5°C. Within 3 minutes, we were able to restart it with the same ΔT of 3.5°C, though 12 minutes later (21:15), it stopped again without the ΔT value changing. With each cycle, the frosting ice increased the motor resistance to start-up, and this could be felt in the thrust required to "kickstart" the motor. Again at 21:16 it started (with Δt still at 3.5°C), only to stop definitively 5 minutes later with ΔT at 3.3°C.

These results suggest that, for best around-the-clock performance, the motor proper with the levers and pistons should be encased in a subatmospheric transparent plastic housing, and sequestered thereby from the atmospheric conditions to which the top plate of the motor must necessarily be exposed.

The employed final design of the complete HYBORAC as tested in the present report is shown in Figure 10, where the two insertion modules (the small and large black cages or inverted BORACs discussed in the Introduction) are presented as being either mounted on two hybrid ORAC three-side platforms—for daytime use—or inserted, one inside the other (with the larger black cage upside down), into the NORAC structure to form the complete HYBORAC for nighttime usage, with the tight insulated lid of styrofoam capping the whole arrangement.

As shown in Figure 10, the Achilles heel of the whole arrangement lies in having to disassemble the cage from its platform and the motor from the cage, in order to insert the cages into the NORAC, put the lid on, and reinstall the motor on the small cage through the hole on the lid. This can be greatly improved by permanently encasing the black cage itself into a sealed transparent plastic box, as shown in Figure 11, such that, aside from the spurious cooling that occurs when contact is broken between the cage and the Stirling bottom plate, the black cage retains maximum latent and sensible thermal energies.

Lastly, we should note that, in the matter of the top plate of the Stirling motor, it would be best if this plate were coated white, rather than black. This has the virtue of absorbing less sensible heat from the surrounding air, and of forming less frost during nighttime. As the reader knows by now, we employed an insulated, reflective cap over the top plate of the Stirling motor during daytime

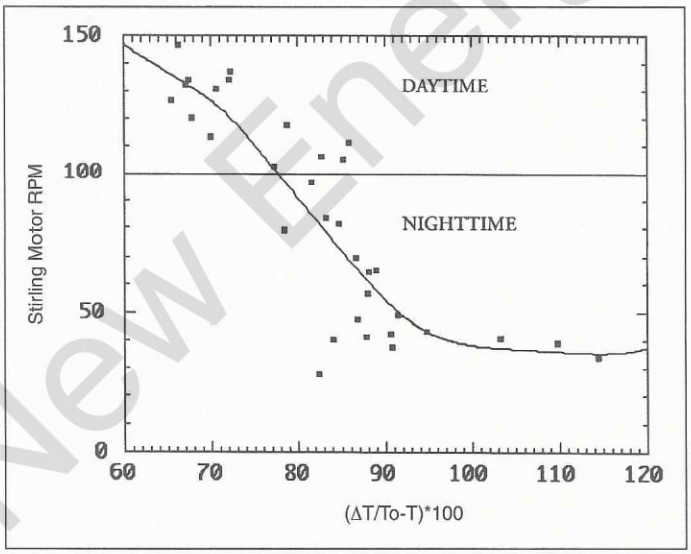

Figure 8. Stirling motor rpm as a function of the ΔT recovery efficiency of To-T. Lowest motor speeds coincide with the highest recovery efficiencies. Efficiencies >100% indicate that the heat pumped out of the cage cavity exceeds heat generation inside of it.

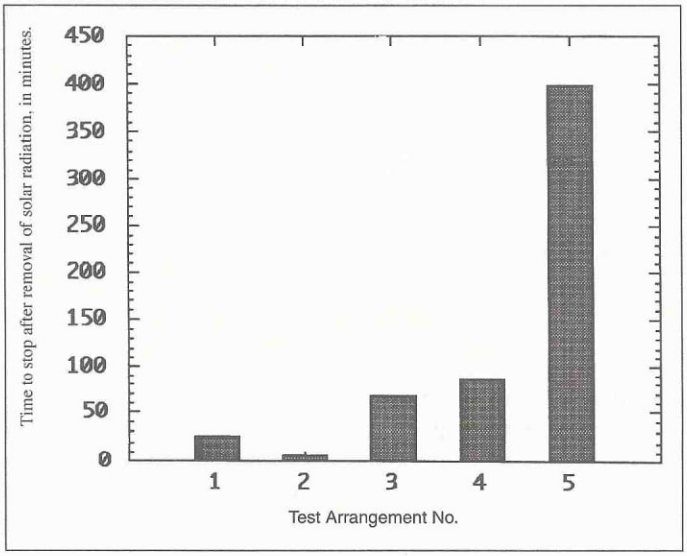

Figure 9. Comparative experiments conducted between the 10th and 18th of November 2001: all test arrangements were exposed to solar radiation for a full day and the time that the same Stirling motor took to come to a stop was measured. 1. Motor atop varnished pine box encasing a Faraday cage (1x ORAC); 2. Motor atop a reflective Faraday cage; 3. Motor atop a matte black Faraday cage in the daytime HYBORAC configuration; 4. Motor atop a matte black Faraday cage in the daytime HYBORAC configuration, but with the exposed metal surfaces covered by a three-panel, 4" cork cover; 5. Motor atop a black Faraday cage in the nighttime complete HYBORAC configuration.

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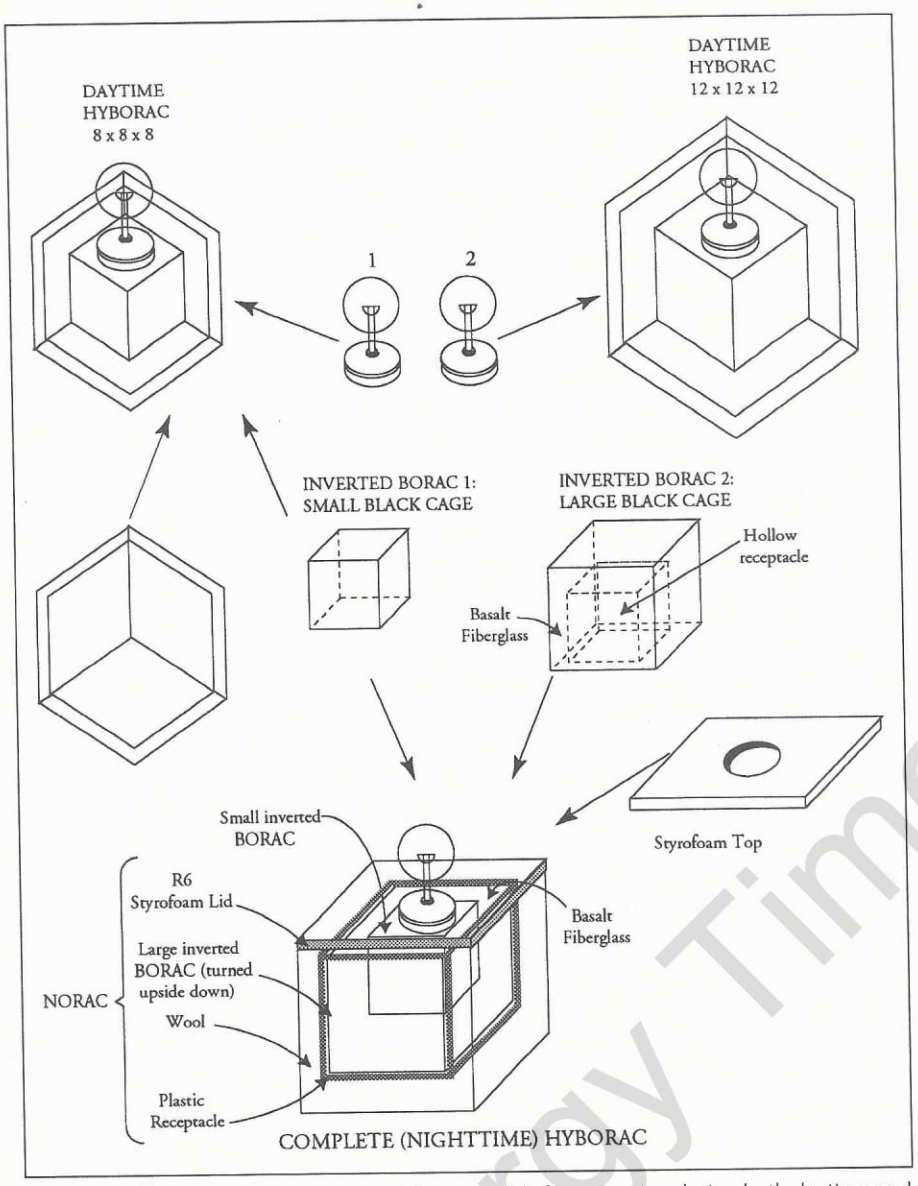

Figure 10. Complete HYBORAC modular assembly for operation during both daytime and nighttime. During daytime operation, the two matte black Faraday cages are inserted into three-sided platforms and directed to solar radiation, each driving its own Stirling assembly. At night, the smaller cage is inserted inside the larger one and both into the NORAC envelope, with one of the motors mounted on the top.

operation. This cap could be perfected into a removable heat sink designed to shade the top plate and cool it by efficient dissipation of heat. A cross-section of such a design is shown in Figure 12. We should also remark that, upon insertion of the boxes into the NORAC in order to assemble the complete HYBORAC, the daytime cap of the upper plate of the motor is removed. But since the distance between the plates is very small, the upper plate ends up being buried into the styrofoam top and sheltered from cooling winds. A better cooling of the upper plate was achieved in several tests by placing solid metal cylinders standing vertically over the plate. By being exposed to the atmospheric air well above the complete HYBORAC, the cylinders rapidly absorb any heat present in the Stirling upper plate.

At peak daytime performance, the Carnot cycle efficiency of the HYBORAC was:

$$[(T_H-T_C)/T_H]*100=(\Delta T/T_H)*100=(22.5°\text{Kelvin})/(295.5°\text{Kelvin})*100 = 7.4\%$$

In the previous report we had hoped to double the maximum efficiency to 8%, and we have now nearly achieved this.

It is likely that the suggested improvements to the black cage module itself will translate into still better efficiencies. Future tests will also aim to extend nighttime winter operation—from 7 hours to as much as 17 hours—which will require addressing the problem of frost forming on the working surfaces.

Discussion

It is unlikely that anyone predisposed to believe that driving Stirling engines from ORAC arrangements is all about retaining heat transmitted from the Sun will be convinced by the present experiments—anymore than those reported in the preceding monograph—that the daytime HYBORAC or the nighttime complete HYBORAC function, instead, by accumulating both sensible and latent heat derived, essentially, from the ambipolar massfree radiation emitted by the Sun, and are capable of maintaining their cycle of accumulation and draw during nighttime (in the absence of a motor pumping out the sensible heat), as we have demonstrated elsewhere.[2]

Indeed, as far as we are concerned, there is no way to legitimately discard the thermal anomaly of Faraday cages and ORACs discovered by W. Reich: it cannot be explained by the target flux density based upon the accepted power value of the solar electromagnetic constant[2] anymore than it can be explained by the blackbody modal absorption spectra of BORACs (Black ORACs) or WORACs (White ORACs).[2] On the contrary, as we found in previous communications,[2, 3, 4] every sign indicates that, aside from the sensible heat or photon energy (the, properly speaking, electromagnetic energy) which ORACs absorb, they also draw in latent heat and convert captured, attenuated, residual ambipolar radiation into both latent and sensible heat. Aetherometrically speaking, it is apparent that sensible heat is both absorbed and generated by ORACs. The question in the present type of experiments is not where this heat comes from, but whether, in the absence of solar radiation, the heats retained plus the heats generated are sufficient to drive low delta MM6 motors for substantial periods of time.

It is in this context that both dynamic and mechanical factors must be taken into account. Retention of heat is an important aspect, but it applies as

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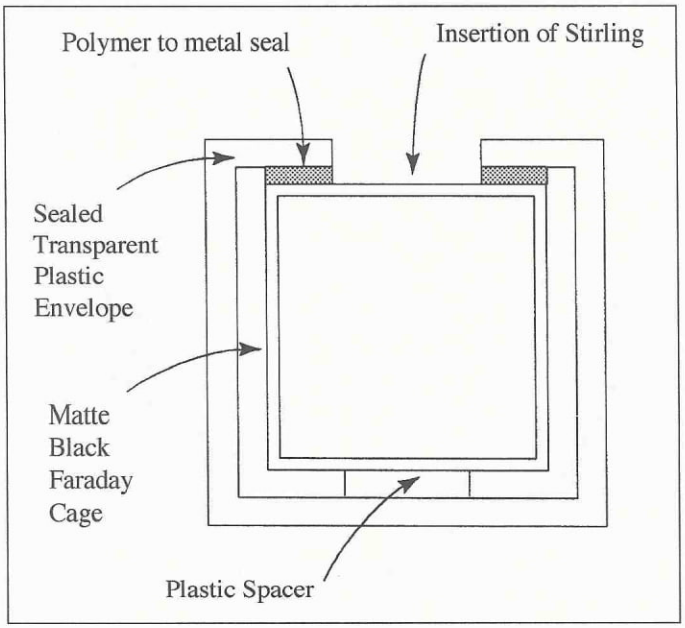

Figure 11. Proposed design of the inner cage module, aimed at maximizing the capture of both latent and sensible heats, and designed for minimal energy loss during removal from the daytime platform and insertion into the complete HYBORAC structure for nighttime operation.

much to the retention of latent heat as to that of sensible heat—especially since, as aetherometric science contends, sensible heat will be continuously expressed from the pool of trapped latent heat inside the core cage. Maximizing the trapping of both heats derived from ambipolar solar radiation will require, as we have suggested, a sealed black cage, since these heats are associated with air molecules. Maximizing their retention by employing the complete HYBORAC structure will assure that the diminished generation of sensible heat, during nighttime periods, from either latent heat or ambipolar radiation, can still balance out the heat-pumping constantly carried out by the motor action. The fact that in several experiments we observed repeated increases of ΔT after periods of depressed values that failed to support motor action, and thus, that this action would repeatedly return, suggests that, with the indicated improvements, a complete HYBORAC might sustain Stirling motor action in cold climates for another 5 hours or so, if not for a full around-the-clock period.

Having arrived at this point, we must question the utility of the device, beyond demonstrating "free" power extracted from the environment. The reader should note that we have not conducted power or work tests on the performance of the motor, or proposed any intrinsic motor improvements that would increase its power output, or calculated energy densities for the complete device. But there are a few basic facts which, in this context, we should highlight—first, that the device is, in general, of rather simple assembly and repair, despite the fragility of the MM6; secondly that, if volumes matter in choosing the best drives for Stirling motors, as both of our reports on this subject indicate (see, for instance, Figure 4 in reference[1]), we have no data preventing scalability of the device. On the contrary, a larger pool of energy in a larger volume should present easier solutions to these problems. Thirdly, that the present apparatus—and thus the existing design of the complete HYBORAC—is likely to already be capable of yielding a round-the-clock performance in a climate that has 12 to 15 hours of daily solar irradiation—as opposed to the 8 to 9 hours of an autumnal Toronto at 43° N latitude when these tests were conducted. This, with the proviso that daytime would experience a significant amount of exposure to solar radiation—the *sine qua non* of operation of these devices—given that the local ambipolar radiation of the Earth drawn into the devices at nighttime is a contribution that is too small to power these motors, and is best captured by a passive electric device which we have also invented, rather than by a Stirling coupling. However, one still wants the complete HYBORAC to be efficient at drawing in terrestrial and atmospheric ambipolar OR radiation during nighttime, in order to regenerate the sensible heat constantly being exported by the Stirling motor action. Likewise, for its performance during clouded weather, one hopes to maximize, with the sealed plastic design of the black cage, the capture of what little solar radiation escapes trapping by cloud systems and haze. Lastly, we

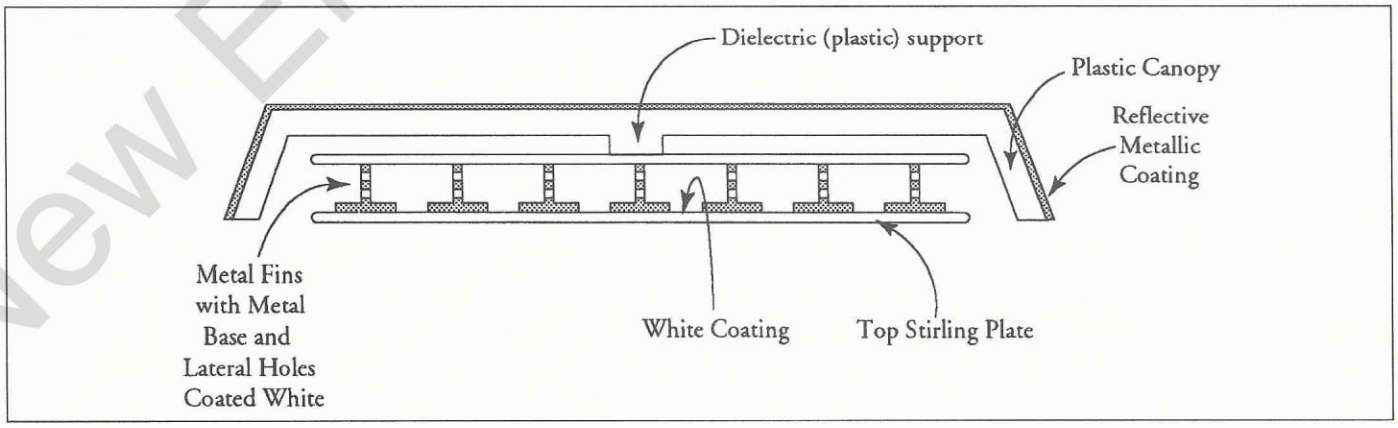

Figure 12. Proposed cap structure for the Stirling upper (cool) plate to be employed during daytime operation under incident solar radiation, and designed for maximum shading and cooling of that upper plate.

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should note that, unlike photovoltaic cells, the HYBORAC can perform useful work for substantial periods of time in the absence of solar radiation.

If we consider the feasibility of the complete HYBORAC as a power generator, then the most direct way to go is to transform the rotor into a spiraloid homopolar rotor, as per the art taught by Tesla,[5] with a suitable radial distribution of magnets, to achieve a low-voltage, high current output.

We should also note that To-T values for the top plate of the HYBORAC black cage (small inverted BORAC) regularly reached 30 to 35°C throughout the eight days of these experiments, yielding working ΔT values of 20 to 25°C and efficiencies of recovery on the order of 75 to 80%. These values meet the targets we posed to ourselves in Part I of this study.[1]

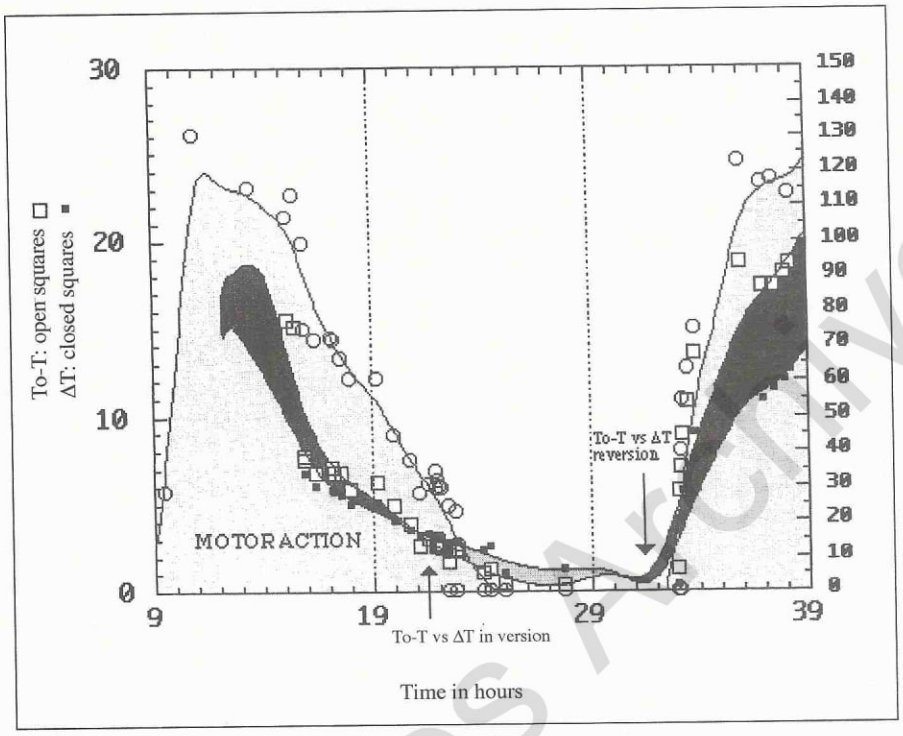

Figure 13. Continuous experiment carried out November 23 and 24, 2001. Motor speed (open circles) is measured by the right ordinate, and To-T (open squares) and ΔT (closed squares) is shown on the left ordinate, in °C.

Addendum

On November 23 and 24 we performed another around-the-clock run with the complete HYBORAC. The results are shown in Figure 13: motor speed is clocked over 30 hours, beginning at 09:30 on the first day; and To-T plus ΔT are clocked for a 24 hour period, from 15:10 on the first day until 16:25 on the second day. On the first day, the motor ran continuously for nearly 14.5 hours. Again an inversion of the (To-T)/ΔT differential accompanied by frost was observed ca 2 hours before the motor came to a stop. And again at 09:00 on the next morning, upon extraction of the HYBORAC from its nighttime envelope, the motor action returned upon reversal of the (To-T)/ΔT differential. At all times, the To-T difference was positive. The lowest value was registered near 04:00 on the second day, at 0.3°C. Upon extraction of the HYBORAC from the complete assembly, brief negative values for both To-T and ΔT were registered. Positive values for both sets of data were again observed within 20 minutes of re-assembly of the daytime configuration. The %RH varied from 50% at 14:00 to 91.5% at midnight on the first day, to 48% at 14:00 on the second day.

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* Concord, ON, Canada L4K2J6; See the complete author biographies in *IE* No. 37.

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SPACE and the Wave-Particle ENIGMA

Dietmar Rothe, Ph.D.*

This paper discusses prevailing theories about the nature and structure of the vacuum space, of matter and of light, and then demonstrates that the wave-particle paradox can easily be resolved if space, instead of electromagnetic radiation, is assumed to be quantized. Electromagnetic radiation is considered to be a pure wave phenomenon and the photon an imaginary concept.

The Logical Universe

Science is a valid endeavor for discovering valuable knowledge about the structure and laws of our physical world. In that pursuit, the scientific method has been most successful for analyzing and utilizing the forces of nature. Without it, we would not be able to send a spacecraft to Neptune, we could not communicate globally, and the Earth could not support six billion people.

Should we not consider it an idiosyncrasy of scientific arrogance, however, to demand that all processes in the universe should yield to human logic and mathematical prediction? That we are able to describe a natural process by a mathematical equation, a short-hand notation of a logical statement, is amazing enough. Yet, in accordance with the scientific method, this equation is often treated as a self-consistent reality, to which all related processes should conform. This circumstance makes scientific prediction possible, but we tend to forget that mathematical formulations are by necessity only incomplete descriptions of natural events.

No *a priori* requirement exists for reality to conform to logical thought. Consider an elementary form of logical inquiry, such as: "What is seven times eight?" Every school child knows there are an infinite number of wrong answers, but only a single correct one for such a mathematical proposition. Similarly, we could imagine an infinite number of illogical universes. A universe built on logic, however, will be working with internal consistency and will be able to bring forth complex forms of organization. Besides creativity, logic is seen to be a necessary ingredient, which allows this universe to develop higher complexity. If it were not built upon logical principles, our universe would have self-destructed a long time ago. Thus, logic weeds out unworkable systems, making it the cornerstone of nature and our sciences. There could be no useful science or technology if this were not so. As a body of descriptive knowledge, science is thus generally self-consistent and stands on its own merits. Despite its success, however, all science is predominantly descriptive. In the last analysis, it explains very little, leaving room for alternative interpretations of such scientific knowledge.

Mysteries and Paradoxes

According to accepted science, all material substances are made of atoms and molecules, and these in turn are composed of more fundamental particles, such as protons, neutrons, and electrons. Throughout our more recent history, scientists and philosophers have tried to find the fundamental building blocks of the universe. High-energy particle physicists have spent many decades smashing high-energy beams of speeding protons and other ions into nuclear targets, to see if the known nuclear particles could be dissected into more fundamental building blocks. They have succeeded in creating a bewildering zoo of so-called *elementary particles,* such as quarks and mesons; but none are stable for much longer than a billionth of a second. So the question arises whether these quasi-particles have any meaningful relationship to the internal structure of protons, neutrons, and electrons. Physicists have also searched in vain for elusive magnetic monopoles, whose existence is inferred from the apparent symmetry of electric and magnetic effects. Magnetic monopoles would carry magnetic charges in analogy to the unit electric charges carried by protons and electrons. Here is an example where nature refuses to conform with theory. Similarly, the search for gravitons, which are thought to be needed for explaining gravitational interactions, has so far been futile.

Then there is the neutrino. The simultaneous conservation of energy and momentum in particle dynamics requires the existence of another stable *particle*, the neutrino. The neutrino is believed to have zero charge and zero *rest mass*, and it is almost impossible to detect. It is presumed to move with the speed of light. In many respects, the neutrino has properties similar to those of the photon, except that it carries half a unit of spin angular momentum, compared with the photon's unit spin. We will later on deny particle status to the photon. It is similarly possible that the neutrino is also such an illusionary quasi-particle. And it may also be a vibrational space disturbance propagating at the speed of light, but with no particle actually moving along the apparent path of the neutrino.

As another consequence of the conservation laws, each elementary particle should have a corresponding antiparticle. When a particle is *created* in a high-energy collision, a mirror image of that particle also appears, having opposite spin and charge. We thus have antielectrons (positrons), antiprotons, antineutrons, and antineutrinos. Antiparticles can, in principle, form stable antiatoms, antimolecules, and antimatter objects. Matter and antimatter cannot coexist in close proximity, however, because upon contact the corresponding particle-antiparticle pairs will annihilate and transform them-

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selves into gamma radiation. We do not know whether antimatter has negative mass or positive mass, or whether mass is an absolute quantity that can be neither positive or negative. Most scientists believe the latter to be true. Negative mass would lead to the paradoxical inference that a piece of antimatter would accelerate in a direction against an applied force. Moreover, antimatter would be gravitationally repelled from ordinary matter. No such repulsion has yet been observed.

Our physical world, as we know it, appears to be constructed entirely of matter, which brings us to the mystery of the conspicuous absence of antimatter. We can be certain the Sun and the solar planets are made of the same ordinary matter. Otherwise we would see our space probes self-destruct in a blinding flash of light and gamma rays when they land on another planet. And solar wind particles would create an aura of gamma radiation as they strike planetary atmospheres. If creation of the universe followed the same physical laws that we observe today, then equal amounts of matter and antimatter should exist. Where then is all the antimatter? Is every other star made of antimatter, or every other galaxy, or are there anti-universes? We cannot tell from the light received, since antimatter atoms and ordinary atoms give off identical electromagnetic radiation.

Whereas we do not know much about the substructure of electrons and protons, we can be fairly certain that, on a coarser scale, atoms consist of protons, neutrons, and electrons. The first workable model of the atom was proposed in 1912 by Niels Bohr (1885-1962) and Ernest Rutherford (1871-1937). It is analogous to the familiar model of the solar system and has planetary electrons orbiting around a massive central nucleus, made up of protons and neutrons. And, as with the solar system, most of the atom is empty. The nucleus and the electrons occupy less than a millionth of a millionth of the atomic volume. We thus find it hard to understand what makes material objects so solid. Electrons *orbit* within their allotted shells at nearly 1% of the speed of light, completing more than 10^{15} revolutions each second, thereby weaving a tightly knit, impenetrable shield, which defines the size of the atom. This explains a person's inability to walk through a wall. The electron shells of the atoms in a person's body cannot readily penetrate the electron shells of the wall atoms. A typical size for an atom is one-tenth of a nanometer. Because atoms are so small, we need an incredible number of them to make up familiar objects. For example, a cubic centimeter of solid aluminum contains 6×10^{22} atoms. This number is larger than the number of sand grains on all the ocean's beaches. As small as atoms are, electrons and protons are 20,000 times smaller yet.

Quantum and wave mechanical theories have since refined Bohr's model of the atom. Today's conception of the atom is one in which the electrons are smeared out over entire spherical shells and other symmetric configurations centered around the nucleus. The electron is no longer considered a hard particle, but a fuzzy blob of energy, which might be detected anywhere within the cloud pattern described by a mathematical probability function. And it cannot with any certainty be found at any particular point.

Modern physics recognizes four different forces in nature: gravitational, electromagnetic, strong nuclear, and weak nuclear interactions. But the only two forces of nature with infinite range are gravitation and electromagnetism. How these forces can act over large distances has never been explained and is one of nature's best-kept secrets. Theoretically, this action-at-a-distance can be treated mathematically by postulating a force field, a concept first introduced around 1850 by Michael Faraday (1791-1867) for illustrating electric and magnetic interactions. Field theory has since been extended to describe gravitational interactions and fluid-dynamic flow fields.

More recent theories propose that electromagnetic action-at-a-distance is facilitated by an interchange of photons, and similar gravitational action by an exchange of gravitons. However clever these ideas may be, field theories and particle exchange theories are by necessity only mathematical crutches, and neither provides any real understanding for solving the action-at-a-distance mystery. Could it be that we do not understand the forces of nature because we do not grasp the true nature of space and time? We intuitively and unquestioningly accept the concepts of space and time as fundamental. In our Newtonian and Cartesian way of thinking, space and time provide the framework and arena for all material activity and for all our experience. Most of us take it for granted that space and time had to exist before everything else was created.

The advent of the relativity theories by Albert Einstein (1879-1955) and of the quantum mechanical theories by Max Planck (1858-1947), Erwin Schrödinger (1887-1961), and Werner Heisenberg (1901-1976) shattered the mechanistic underpinnings of science during the early part of the twentieth century. Einstein tied space and time together by postulating a four-dimensional space-time continuum as a reference frame for all world events. Moreover, in his famous mass-energy relation he declared matter to be just another manifestation of energy. He proposed that all energy has mass and that energy is *the* fundamental stuff of the universe, that energy is in fact *all there is*. Space and time were no longer independent of the energy distribution in the universe. Large accumulations of energy in the form of matter were believed to warp the space-time matrix, explaining why light rays bend around massive objects like the Sun. Relativistic concepts also demanded that the flow of time could no longer be considered uniform throughout the universe.

Whereas Einstein's theories afforded a fresh look at basic physical interrelationships and processes, they also created a new set of paradoxes, which cannot be resolved philosophically, even though they may be *justified* by mathematical manipulation. We must remember that mathematical description is a useful tool to describe observed reality, but it is not a reality in itself. The paradoxes arise out of the theories' confusion about the nature of space. The classical theory of light as an electromagnetic wave needed an *elastic ether* to carry light vibrations. Experiments designed to detect our motion through this ether of space were unsuccessful. Einstein used these experimentally inconclusive results as the primary axiom for his Special Theory of Relativity, published in 1905. In common language, he postulated that the speed of light measured by an observer is constant, independent of the observer's motion relative to the source or anything else. There could be no preferred reference frame attached to space itself. With this postulate, Einstein denied the existence of a light-carrying ether. Space had to be absolutely empty, a nothingness without any properties. Eleven years later he contradicted himself with his General Theory of Relativity, which unequivocally depends on space being a medium that can be distorted

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and warped. His Special Theory, however, is what leads the unwary theoretician into absurd contradictions.

The explosive technological growth of the late twentieth century has provided physicists with new powerful instruments and tools for probing and exploring the microcosm and macrocosm. Theorists have been working overtime to deal with many new discoveries in the subatomic world, as well as in the cosmos at large. While their theories are often able to describe newly-discovered oddities correctly, they do not add much to our deep understanding of nature. Quantum physics and relativity theories deal with new phenomena by asserting new postulates and by making corresponding adjustments to the mathematical framework. In the subatomic arena, new quasi-particles, like gluons, gluinos, and quarks, are conjured up to account for any surplus or missing mass. And if these enigmatic particles do not behave according to theory, new rules are made up to connect their odd behavior with imaginary properties, such as strangeness, color, and flavor.

Another trend in making observational data fit theory is to add more dimensions to our baffling world. Enlightened scientists know that a suitably complex mathematical construction can be created to fit any real or imaginary set of observations, provided a sufficient number of arbitrary coefficients and constants are inserted, all adjustable and tunable to fit the data. Modern cosmologists delight in creating such *Theories of Everything, Superstring Theories,* and the like, which propose that our world is 10, 11, 15, or 27-dimensional. Meanwhile we are still trying to fathom the enormous complexity of Creation, the wave-particle duality of light, the nature of time and space, electric charge and gravitation, the mysterious action-at-a-distance, the secrets of nuclear structure, the formation of stars and galaxies, and the significance of quasars and black holes.

Relativity and Space

Nothing can go faster than the speed of light. Such is the creed of modern relativists. But is this an established fact? Einstein stated in his original papers that, in a relativistic sense, no material body could be *observed* to travel faster than the speed of light. This was perfectly logical, because he used light signals as the measuring stick for all world events, for determining relative motion of objects and for defining simultaneity. He made the speed of light an *absolute* limit only in his later writings. Turning such a relativistic concept into an absolute quantity, however, is contradictory and unjustified. Relativists consider absolute concepts to have no real meaning in any event. We are confronted here with a philosophical problem, stemming from the belief that an observer's sphere of consciousness is limited to a small section of space and time. Those of us who believe in an ever-present, all-encompassing, eternal spirit consciousness have no problem with absolute ideas. We can view the entire universe with our mind's eye without being limited by the speed of light.

Cosmologists consider the universe finite but unbounded, like the surface of a sphere. Yet, if the universe is finite, then there must be a center of mass. The latter would conveniently serve as a distinct point of reference for everything else, even if this center lies outside of our observable three-dimensional space and is inaccessible, which may be the case should our world have four or more spatial dimensions. Because electric and gravitational force fields fall off inversely with the square of distance, however, our world must have three spatial dimensions and no more. This is required by the conservation of energy (mass) and charge. A simple mathematical analysis can show these force fields falling off inversely as the cube of distance, if the world were four-dimensional. The laws of physics just do not support the existence of any fourth or higher spatial dimensions.

The impetus for Einstein's theories came from experimental results that failed to prove the existence of a vacuum *ether*, thought to be necessary for the propagation of light waves through space. In 1887, Michelson and Morley[1] (MM) showed that light propagates with the same speed in the direction of Earth's motion as in the opposite direction. In the MM experiment, a light beam was split in two with a partially reflecting mirror positioned at 45° with respect to the beam. The two beams were reflected back and forth between mirrors in mutually orthogonal directions. Then the beams were recombined and made to interfere, so as to produce optical fringes. The fringes were expected to shift when the apparatus was rotated relative to the known orbital motion of the Earth. No fringe shifts were detected outside of the experimental uncertainty. During the next fifty years the experiment was repeated more than a dozen times with increased finesse and accuracy. Some experimental setups were so sensitive to vibration that the City of Cleveland agreed to halt all streetcars during one of the experiments. As much as scientists tried to detect an *ether drift*, their results remained inconclusive. The majority of these experiments did not actually measure light velocities, but relied on optical fringe shifts. Thus, the interpretation of the experiments may be questioned, because they did not account for changes in phase and frequency of the light waves reflected from moving mirrors. Then there is the nagging fact that spinning versions[2] of the MM experiment apparently proved the existence of a preferred reference frame.

The refutation of the ether was not readily accepted by the scientific community. Several attempts were made by theorists to invent compensating effects which could be used to explain the MM results and save the ether theory. Among these efforts was a proposal by G. Fitzgerald (1893) and H.A. Lorentz (1895), suggesting that fast moving bodies shorten their dimension in the direction of motion. Instead of a contraction in length, a corresponding time dilation would also serve to explain the MM results. According to this theory, a stationary investigator observing a moving clock would find it ticking more slowly. Neither the Lorentz-Fitzgerald contraction nor the time dilation effect were successful in saving the ether concept. Instead, Einstein incorporated both ideas into his relativity theories. Einstein's version of the time dilation effect leads to the famous twin paradox,[3] which requires pages of hand-waving arguments to explain.

The Special Theory of Relativity is inconsistent with the concept of a universe functioning according to logical principles. Whereas the theory assumes logic to prevail for all other physical phenomena, it makes an exception for the vector addition of velocities, insofar that the most basic logical truth of 1 + 1 = 2 does not apply here. According to the Special Theory, velocities cannot be added algebraically. For example, consider a spaceship traveling away from the Sun at 0.9 times the speed of light. Light emitted from the Sun at speed c overtakes the spaceship. A scientist on the spacecraft confirms that the ship is moving away from the sun with 90% of the speed of light by measuring the rate of decrease of the apparent diameter of the Sun. He also measures the speed of light rela-

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tive to the ship and finds, in accord with theory, that the light still overtakes him with a relative velocity of c. Hence, he concludes that c minus 0.9 c equals c, a paradoxical result. This illogical, non-algebraic speed difference is also inconsistent with the observation of a Doppler shift in light frequency. The first-order Doppler shift is a classical effect that depends on classical velocity differences. Light passing a moving observer should not change in frequency, if the observer always measures a fixed light speed c, irrespective of his own speed relative to the source.

The best known mathematical relation, associated with the Special Theory of Relativity, is the mass-energy equivalence formula, $E = mc^2$. Popular interpretation of this formula holds that mass can be converted to energy and vice versa. Moreover, nuclear fission and fusion processes are believed to represent dramatic proof of Einstein's theories. Both notions are erroneous.

The correct interpretation of the formula regards mass as a measurable *property* of energy. Energy has mass. In nuclear fission and fusion reactions, energy is conserved, and thus mass is also conserved. Matter energy is being converted to radiation energy and heat energy, but no energy is created, and no mass is destroyed. The celebrated formula can be considered as a mere definition of mass, *i.e.* $m = E/c^2$, where $1/c^2$ is the proportionality coefficient. Whereas Einstein derived this formula by considering the relativistic mass increase of an electron accelerated to high velocity, it could just as well have been derived from classical and quantum mechanical concepts, without resorting to Lorentz-Fitzgerald transform factors for length, mass, and time. Hence, confirmation of $m = E/c^2$ does not in itself validate the Special Theory of Relativity.

Einstein denied the existence of a vacuum ether of space and asserted space to be a nothingness without properties. Yet space is known to have specific properties, which can be measured precisely, such as its electrical permittivity ϵ_o and its magnetic permeability μ_o. These two quantities define the electromagnetic impedance of space as $(\mu_o/\epsilon_o)^{1/2}$, and the propagation velocity of electromagnetic waves in space as $c = (\epsilon_o\mu_o)^{-1/2}$, two alternative properties of space. And Einstein's assertion of space being empty is strongly contradicted by the phenomenon of vacuum polarization. When an isolated charged particle, such as an electron, is observed in vacuo, it appears to be surrounded by ephemeral particles of opposite charge (positrons). These particles oscillate in and out of existence, here one moment, there the next, like will-o-the-wisps. Their transitory life is very short, even on a subatomic time scale. These *virtual* positrons are thought to be members of electron-positron pairs, appearing out of the vacuum and vanishing again by recombining with each other. During their short lifetime, the positrons are drawn closer to the free electron, whereas their negative partners are repelled to a greater distance. This constitutes an electric polarization of the space around the original electron. The electric charge measured as the charge on the electron may, therefore, not be the real charge of the *bare* electron, but rather the charge of an electron *clothed* in its induced vacuum charges. The actual bare charge of the electron may be significantly larger than its measured value.

When studying ancient philosophy and off-beat scientific theories, we come across a recurring belief in a fine-structure underlying all space and all matter. This fine stuff underlying the atomic order is thought to be linked with spiritual energy. The presence of such a sea of spiritual energy would clarify how thought and spiritual power can control, or even create, matter. Many esoteric beliefs and theories consider space, and hence the entire universe, to be made up of two kinds of elementary energy units, opposite but complementary, extremely tiny, and virtually infinite in number.

Pre-Taoist philosophers in China distinguished within every natural object two interacting energy modes, the positive *Yang* energy and the negative *Yin* energy. In more recent times, the English physicist Dirac[5] proposed a theory of a sea of virtual electrons, which occupy all space, but are normally undetectable. *Lifting* an electron *out* of this *Dirac Sea* would leave a *hole* that would act like a positively charged particle, the positron. Dirac's theory later served as a model for the positive hole concept in modern semiconductor technology. But the Dirac sea of virtual electrons imprisoned in positive holes, as a model for the vacuum space, was never given serious consideration by established science. More recently, Simhony[6] has revived and expanded the electron-positron model of space. He believes space to be densely populated by actual electrons and positrons, arranged in a three-dimensional lattice, in the same way as negative chloride ions and positive sodium ions are arranged in a crystal of rock salt. Whereas his theory can naturally explain many of the quantum mechanical assumptions and postulates, his papers have been rejected and barred from publication, because his theory would re-establish a preferred frame of reference.

Simhony calls the space lattice *epola* and assumes the electrons and positrons are held in the lattice with a binding energy of $E_b = m_ec^2 = 511$ keV. If this binding energy is simply electrostatic, then the space between adjacent particles in the lattice is approximately five femtometers (5×10^{-15} m). This leaves little room for particles of ordinary objects to pass through space unimpeded, making it hard to accept the epola theory without reservations. It goes against common experience, which tells us that material objects can pass freely through empty space with zero resistance.

If we were to add up all of the individual particle masses in the epola, we would determine a mass density of 10,000 tons per cubic centimeter of space. This is ten billion times the density of ordinary matter. So, how could space possibly be so transparent to moving objects? The secret lies in the concept scientists call *binding energy*. Remember, we stated earlier that all energy has mass, and that there probably is no such thing as negative mass. Well, binding energy is the sole exception. It is an energy hole—not just the absence of energy, but an abyss that swallows energy. Binding energy is negative energy and can be considered to have negative mass.

We can best illustrate this negative energy by examining the atomic nucleus. The strongly attractive nuclear forces create an energy hole, which keeps the protons from flying apart due to their electrostatic repulsion. Because of this nuclear binding energy, the mass of a nucleus, *i.e.* the total energy in the nucleus, is always less than the sum of the masses of the component nucleons. The nuclei of some elements are more tightly held together than others. For example, a helium nucleus is more strongly bound (more stable) than a deuterium nucleus. So, when two deuterium nuclei are fused into a helium nucleus in a nuclear fusion reaction, there is a net loss in nuclear energy. The energy difference, *i.e.* the increase in binding energy, is released as radiation and kinetic energy.

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In the epola model of space, the binding energy per particle is equal to the matter energy of the particle itself. The electrons and positrons disappear into the energy holes produced by the interaction of their electric charges, making them undetectable from our coarse-matter world. The externally measured mass density of the epola space is thus equal to zero. Having been robbed of their energy, the electrons and positrons in the epola space are therefore unable to interact with ordinary matter and do not resist the motion of objects through the vacuum of space.

The epola lattice constant is probably also much larger than the five femtometers assumed by Simhony. Remember, it may not be possible to measure the bare charge of an electron because of the positive electric clothing induced in the vacuum. If the bare charge of the electron is taken to be 100 times the measured value, for example, then the particles in the epola space will be 10,000 times farther apart. The per-particle binding energy will still be 511 keV, and the epola as a whole would still be massless. It would then be far more transparent to the passage of nuclei and electrons of ordinary objects as they move through space.

So, does the fine-structure of space consist of electrons and positrons, hidden in energy holes of their own making? Or is there a still finer microstructure underlying the electron-positron space? At least one British engineer seems to think so. R.D. Pearson[7] proposes that everything in the universe is ultimately made up of positive and negative *cosmons*, thousands of times smaller yet than electrons. He also believes that these cosmons are akin to spiritual energy, and that the power of the spirit over matter acts at that level.

When we contemplate all theoretical and observational aspects of space, taking into account intelligent speculation and ancient wisdom about the structure of the universe, we should seriously consider a vacuum space made up of oppositely charged energy units, too small to detect, but underlying everything there is. We will call them energy units or space elements, rather than particles, because particles imply a solidity that does not exist at this ultra-microscopic level. Solidity is an illusion of our everyday material world.

The Wave-Particle Enigma

Light is an electromagnetic oscillation of space, propagating with a constant velocity c in a direction perpendicular to both the oscillating electric and magnetic field vectors. We use the term *light* here in a generic sense, so as to include all electromagnetic radiation from radio waves, to microwaves, to visible light, to X-rays, and on to gamma rays.

The fundamental nature of light is wavelike, and its electric and magnetic manifestations are accurately described by Maxwell's Equations,[4] which form the foundation of classical electromagnetic theory. In Maxwell's theory, the propagation of electromagnetic waves depends directly on the properties of a highly elastic *ether*, believed to be filling all space. The wave picture of light could easily explain most optical phenomena, such as diffraction, interference, refraction, internal reflection, polarization, and birefringence. And so everything was well until the year 1900, when Max Planck introduced the first quantum mechanical concept with his *Distribution Law*. The latter was an empirical fit to the emission characteristics of a *black body* (a nonreflective bit of matter—gas, liquid, or solid—in radiative thermodynamic equilibrium with its temperature) heated to a known temperature. Fitting a theoretical curve to the frequency dependence of the measured intensities became feasible only if he assumed that radiation was emitted in discrete quanta, and if the quantum energy was proportional to the light frequency. The proportionality constant h is known as Planck's Constant. Five years later Einstein used the quantum concept to account for the photoelectric effect. Photoelectric emission of electrons from a metal surface occurs only if the light frequency is above a certain threshold. Below that critical frequency, no electrons are emitted, no matter how high the light intensity. This strange behavior could be explained by considering the impinging light flux to consist of individual energy packets, called photons, each with an energy of hf, and each one interacting individually with an electron at the metal surface. By transferring all of the photon's energy to the electron, the forces that bind the electron to the metal matrix could be overcome, liberating the electron. Photons were believed to be similar to the light particles hypothesized by Isaac Newton more than two centuries earlier.

After Einstein published his Special Theory of Relativity and derived his famous mass-energy relation, scientists started to consider seriously the possibility of converting photon energy to matter energy. Perhaps fundamental particle-antiparticle pairs could be *created* with high-energy gamma rays. Indeed, by 1932, Carl David Anderson showed that gamma rays of sufficient photon energy ($> 2m_ec^2$) could produce electron-positron pairs under certain conditions. This discovery reinforced the belief in light photons. Since then, light has been considered to have a dual nature, wavelike as well as particlelike, depending on the phenomenon under investigation. The photon theory is typically applied to explain photochemical reactions, whereas the wave picture is used for elucidating optical refraction, diffraction, and interference effects. The shorter the wavelength of light, the more it seems to behave like a stream of particles. Modern quantum physicists consider photons to be real particles, moving with the speed of light in the direction of the light ray. Particle physicists list the photon as one of the unique elementary particles that make up the universe. This notion makes the photon the weirdest elementary particle known. It does not have a unique energy or mass, it ceases to exist unless it moves at a fixed speed c, and it is its own antiparticle. Calling the photon an elementary particle forces it into a category to which it does not belong. It cannot be a real elementary particle in the same sense as the electron.

The interpretation of light as speeding bullets of energy has created an unresolved paradox, which cannot be reconciled with the more readily observed wavelike nature of electromagnetic radiation. If we accept that this universe is based on logic, then we need to challenge this photon concept. To this effect, we will describe three situations that demonstrate the inconsistency of the photon concept with observation and logic. We will temporarily assume that the Special Theory of Relativity is correct, and that the wave-photon duality of light is a valid representation of reality.

Example 1: The Capricious Photons

Now there are five, then three, and then perhaps two point seven.

Light intensity is proportional to the square of the electric, or magnetic wave amplitude, E_o or B_o, and the photon flux passing through unit area in unit time is intensity divided by the photon energy, hf. Consider now a steady stream of colli-

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mated light of frequency f_o (a laser beam, for example) emanating from a distant star system and passing an observer in a spaceship. The latter is initially at rest with respect to the light source. He will measure a light intensity of $\epsilon_o c E_o^2$ and a corresponding photon flux ϕ_o. Each photon carries an energy of hf_o and passes him with speed c.

Then let the space traveler fire up his rockets and acquire a constant velocity v away from the star, where v is significantly less than c. According to the Special Theory of Relativity, the light waves still pass him with a velocity of exactly c. But does he still measure the same photon flux? One of the axioms of relativity theory requires Maxwell's equations of electrodynamics to be valid in all frames of reference moving at different, but constant velocities. Applying this condition, the electric field amplitude in the light wave, as measured by the moving observer, has decreased by a factor of (1 - v/c). The wave intensity has decreased by the square of this factor. In addition, the light frequency has decreased by the same factor (1 - v/c) due to the Doppler effect, so that the new photon energy is (1 - v/c) hf_o. (For simplicity, the classical relations are used here. Using relativistic expressions would not change the argument.) Consequently, the space traveler will now observe a photon flux density of (1 - v/c) ϕ_o.

Hence, he sees a smaller number of lower-energy photons passing him than before. Where did some of the photons go? He could not have outrun them, because all photons still appear to fly past him with velocity c. If he were moving towards the source, he would see additional photons. Evidently, photons are being destroyed or created, depending on the motion of the observer. This paradox would disappear, if we would allow the photons to have a variable velocity relative to the observer. Hence something is wrong with Einstein's postulate, which says the propagation velocity of light is independent of the motion of the observer, and/or the concept of discrete photons moving with the wave at speed c is incorrect.

Example 2: The Mysteriously Accelerating Photons

When elastic waves (seismic waves, for example) pass from a material of low density to one of higher density, the waves slow down. When they pass back into the lower density medium, they speed up again. The same behavior is observed with electromagnetic light waves passing through an optically denser material, such as a glass lens. The change in wave speed at the boundaries accounts for the phenomenon of refraction. The index of refraction n of an optical material is defined as the ratio formed by the speed of light in vacuo divided by the speed of light within the material.

Now let us inspect this from the photon point of view. As the photons emerge from the far surface of the lens, they must suddenly speed up with almost infinite acceleration. We may ask: What force at the rear surface of the lens accelerates the photons? There is no answer to this question. Again, we must suspect the validity of the photon concept.

Example 3: How Large or Small is a Photon?

One moment as large as a galaxy, at another as small as a molecule of silver bromide.

Next consider the well-known two-slit interference pattern (see Figure 1). When a light wave is passed through two narrow and parallel slits, the emerging light acts as though it was coming from two coherent line sources of light. Along certain directions, the waves are 180° out of phase and cancel each other out, causing zones of darkness. Along other directions, the waves emanating from the two slits are in phase and reinforce each other, creating zones of brightness. All aspects of this interference pattern can readily be explained by means of the wave theory of light. However, this did not satisfy the quantum physicists. They repeated the experiment with extremely low levels of light; so low that, according to their theory, individual photons would arrive at the two slits at distinctly different times. Photon counters, placed in the dark and bright zones of the two-slit interference pattern, produced photon counts that mimicked the pattern expected from the wave nature of light. The photons avoided the detectors in the dark zones, but were counted in the bright zones. A photographic film, exposed for a long time, still showed the customary fringe pattern. When the detectors were placed at the slits, S1 and S2, they confirmed that no two photons arrived at the two slits simultaneously. They were detected only at one slit or the other. The conclusions from this experiment were:

- Individual photons still carry their wave characteristics.
- Photons interfere only with themselves.
- A single photon would have to pass through both slits to follow the interference pattern, but can only be detected at one slit when intercepted.

This is illogical enough, but consider now enlarging the experiment to cosmic proportions. Assume two imaginary slits thousands of light-years apart, but millions of light-years away. Light from a supernova in a distant galaxy or from a quasar, perhaps billions of light-years away, passes through the two openings and is observed here on Earth. The angular geometry is such that wave optics would predict a giant interference pattern, through which the solar system may move, slowly passing through alternate *bright* and *dark* fringes in the course of millennia. Such a phenomenon may actually be observed in the cosmos. Some recently detected, distant quasars[8] may be brightened[9] by such an interference effect, caused by the light being gravitationally deflected around two sides of an intervening galaxy. If it should be confirmed that interference effects occur on a cosmic scale (besides the more commonly observed lensing effects), can we then assume a photon to be smeared out over tens of thousands of light-years, as it passes around both edges of the galaxy? Yet when it is detected on a photographic plate, it suddenly contracts to a fraction of a micron, since the entire energy of the photon is needed to photochemically interact with the small grain of silver bromide. Again, logical thought cannot account for this behavior of the photon.

We could find many more such incongruities arising out of the photon hypothesis. Quantum theory has failed to provide any good physical reason for the optical quanta to have energies proportional to the wave frequency. Classical wave theory predicts the exact opposite relationship. A single low-frequency oscillation contains much more energy than a single high-frequency oscillation of the same amplitude. Wave energies vary inversely as the square or cube of the frequency, depending on the dimensionality of the wave.

A way out of this predicament is to deny the existence of the photon as a speeding particle of light. Photons are not quantities of electromagnetic radiation, but are a characteristic of space. Space, and space only, is quantized, not

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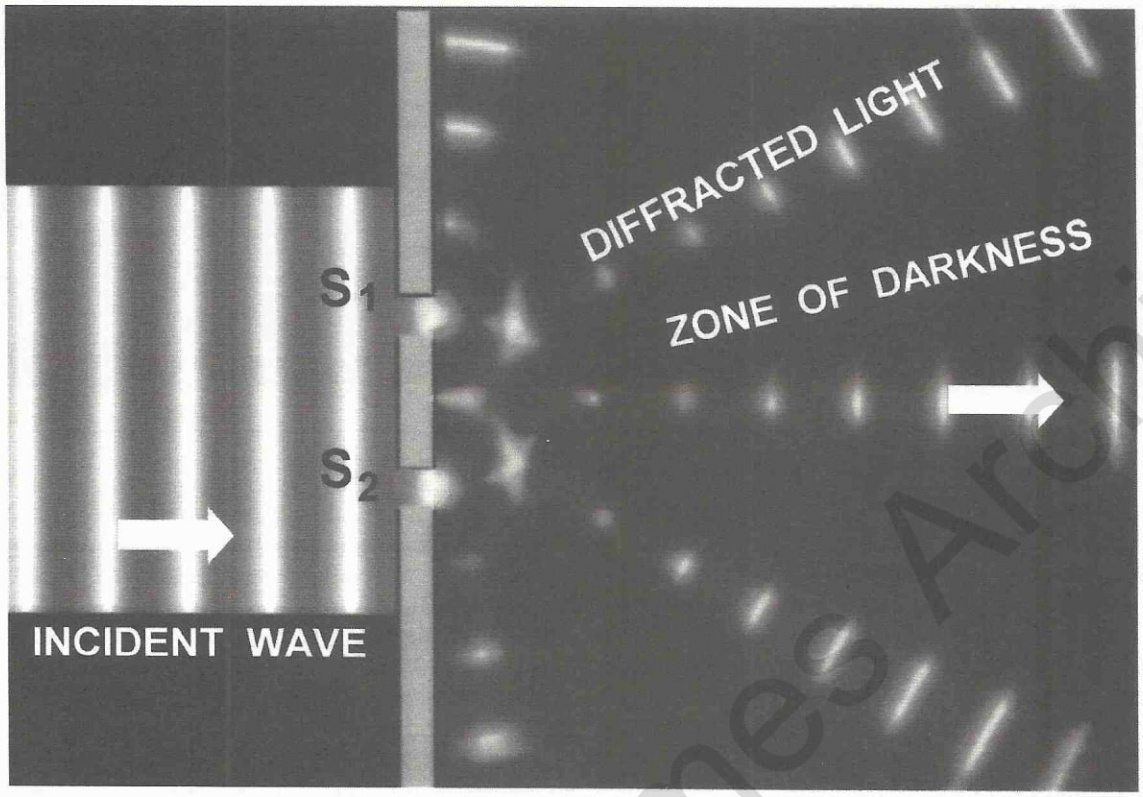

Figure 1. Two-Slit Diffraction and Interference Pattern.

the light waves. Light is wavelike, and the wave-particle duality of light is a myth, brought about by our lack of understanding of the nature of space and time. It is noteworthy that Einstein originally considered the photon to be an *imaginary quasi-particle,* useful only for describing the transfer of energy in an electromagnetic wave. We will consider space to consist of a matrix of elementary energy units held together by electric forces. These space elements, called *spacels* here, are not material particles in the common sense. They may be identical to electrons and positrons, or they may be made of finer stuff. When excited by an electromagnetic wave, these electrically charged spacels execute transverse oscillations in resonance with the oscillating electric field vector of the wave. The transverse oscillation is quantized, giving rise to an apparent quantization of the wave itself. This proposition follows closely the views expressed by Simhony,[6] who considers the photon as representing the average *per-particle part of the energy transferred in the wave motion* through the electron-positron lattice, which he assumes occupies all space. Whereas Simhony's theory does not make use of *a priori* assumptions for the quantization of angular momentum, we will assume that the transverse oscillations of the spacels are quantized in the same manner proposed for the electrons in Bohr's theory of the atom. We do not claim to understand fully the true nature of space, and we do not claim that Simhony's theory is wrong. The following argument is presented only for showing how the paradoxes created by the wave-particle duality can be removed by assuming that space, rather than light, is quantized.

Suppose these fundamental energy units of space (spacels) exhibit the properties normally associated with electric charge, and suppose they are set into sympathetic harmonic oscillations by an electromagnetic wave, which itself originated from oscillations of the spacels. Assume also that the spacels have conventional mechanical properties, such as inertial mass, momentum, and kinetic energy, even though we know there is nothing material about these elements. For space to be neutral, equal numbers of positive and negative spacels are needed. Let us call them σ_+ and σ_-. These positive and negative elements are assumed to be arranged in a uniform matrix, held in equilibrium by electromagnetic interaction and/or by another unspecified force. The space matrix is equivalent to the elastic continuum assumed by Maxwell. Let us now isolate a typical σ_+, σ_- pair. Assume the individual elements have a mass m and are being held apart at an equilibrium distance y_e by an imaginary spring with a spring constant k (see Figure 2). The spring represents all forces acting on the pair of spacels. When displaced from their equilibrium positions, the distance between the two elements will increase and decrease in a sinusoidal manner. This model represents an oscillating electric dipole with the properties of a classical harmonic oscillator. The oscillating frequency f, which is forced upon the dipole by the wave, is normally well below the natural frequency of the spacel dipole.

The displacement-time curve and the velocity-time curve for the oscillating dipole are shown in Figure 3. The sinusoidal motion can be thought of as being generated by the y-component (projection onto the y-axis) of a rotating vector of length A moving with constant angular velocity $2\pi f$, as represented in Figure 3(a). The maximum velocity v_o occurs when $y-y_e$ is zero. It corresponds to the tangential velocity of

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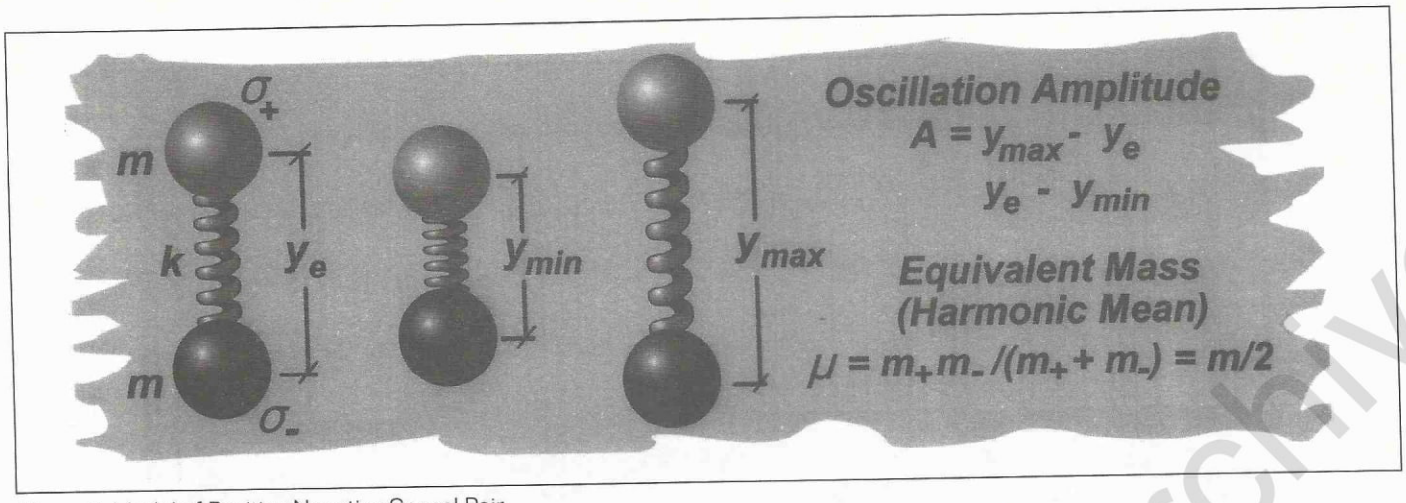

Figure 2. Model of Positive-Negative Spacel Pair.

the equivalent circular motion. Except for extremely high-frequency gamma radiation, this transverse oscillation velocity is significantly slower than the wave velocity c.

We now assume that the angular momentum of the equivalent circular motion is a constant with a quantum value of $h/2\pi$, in analogy to the angular momentum of an orbiting electron in the Bohr atom being quantized. As a consequence of this quantization of space, the amplitude of the oscillatory motion varies inversely as the square-root of the frequency, *i.e.* the higher the frequency, the smaller the amplitude of the resonating spacel. (This condition may be derived directly from considerations of forced sympathetic vibrations in a matrix of coupled oscillators without resorting to quantum-physical concepts; *e.g.* by selecting suitable properties for the spring and coupling parameters.) And as a further result, the transverse vibratory energy of a σ_+, σ_- pair becomes equal to hf; *i.e.* its energy quanta are proportional to the frequency, just as for traditional photons. This energy is transferred from one spacel pair to the next, as the wave propagates through space at velocity c. The number of spacel pairs participating in the wave motion by sympathetically resonating with it determines the intensity of the wave. Since the number of spacels within the sphere of influence of a single wave oscillation is extremely large, the intensity of the electromagnetic radiation has to become inordinately high, before all available spacels become enrolled into participating. Increasing the intensity of the wave beyond this point may force some of the σ_+, σ_- pairs to vibrate with energies of 2hf. This could account for *multiphoton absorption* processes seen in extremely intense laser beams.

In the photoelectric effect, electrons are ejected by the quantized transverse oscillations of the space elements. Photons, as physical particles moving at the speed of light, are not needed. Attempts by optics textbooks[10] to explain double-slit interference patterns in terms of photons passing through one slit or another are futile and nonsensical. Statements like: "photons only interfere with themselves," or "we do not know which slit the photon has passed through when it arrives at one of the fringe maxima," are irrelevant, since no photons pass through either slit. No photon moves in the direction of wave propagation, but space elements vibrate transversely to it. The photon is a hypothetical concept, which only has meaning when electromagnetic radiation interacts with matter to liberate electrons or break chemical bonds, or when it interacts with the substructure of space to produce electron-positron pairs. In all these circumstances, a minimum vibrational ener-

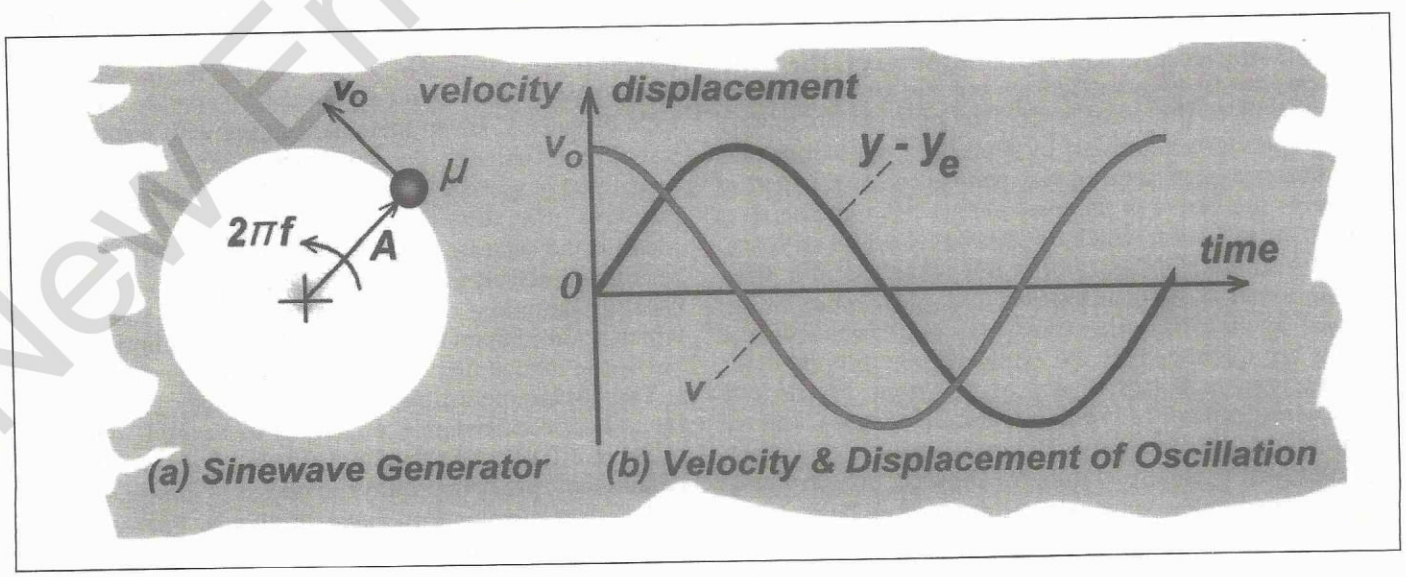

Figure 3. Oscillation of Special Dipole.

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gy of space elements is needed to overcome the binding energy of the particles liberated.

In summary, let us consolidate the ideas expressed in this paper. In discussions on the fine-structure of space, we showed how binding energy can reduce the externally measurable mass density of space. The externally measured mass m_x of a spacel is $(E_m - E_b)/c^2$. If the binding energy E_b of the spacel is equal to its matter energy E_m, then the mass density of space is zero and, according to elastic wave theory, the velocity of wave propagation would be infinite. But our model of electromagnetic waves does not strictly fall into this elastic bulk deformation wave category. (Here we differ from the wave model of Simhony.[6]) In our model, the ether waves consist of quantized local oscillations of the spacels. These elements oscillate individually within their potential wells, created by their electric binding energy. At that microscopic level, each spacel unit has an inertial mass equal to E_m/c^2, unaffected by the binding energy. The elastic forces holding the spacels together in a σ_+,σ_- pair are the same forces that couple neighboring pairs to each other. In terms of microscopic quantities relevant to our model of space, the wave propagation velocity v_p can be shown[11] to be equal to $c(E_b/E_m)^{1/2}$. If the binding energy of the spacel is equal to its *matter* energy, then the wave speed is equal to c, consistent with observation.

Certain experimental observations, such as vacuum polarization and vacuum pair production by gamma rays, suggest a luminiferous ether consisting of an electron-positron matrix, meaning σ_+ may be a positron and σ_- an electron. If there is a primary spiritual microstructure underlying space, consisting of cosmons, or the like, then one might expect the binding energy of these micro-units to exceed their *matter energy*, so that in this spiritual realm, signals can travel at speeds far in excess of the speed of light. Such speculations, however, lead to new contradictions which cannot easily be resolved with present-day science. More of the author's viewpoints, which resolve conflicts in the description of our physical reality, and which integrate material and spiritual aspects into a self-consistent world view, can be found in a recently published book.[11]

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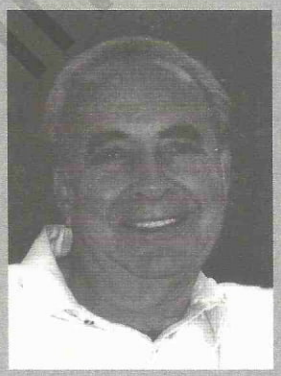
About the Author



Dietmar Rothe was born in a remote corner of Germany in 1934. After surviving World War II, he attended the Hölty Schule in Wunstorf, West Germany, and then completed his formal scientific education in Canada, graduating with honors and a B.Eng. in Engineering Physics from McMaster University in 1961. He then pursued postgraduate research at the Institute for Aerospace Studies in Toronto and obtained an M.A.Sc. degree in Applied Science and a Ph.D. degree in Aerospace Engineering Science from the University of Toronto in 1962 and 1966, respectively. For the next three decades, Dr. Rothe gained scientific knowledge and hands-on experience in the high-technology research field, while contributing to many branches of the physical sciences, ranging from laser physics, optics and spectroscopy, plasma physics and gas dynamics, to pulsed power technology, electrical engineering, mechanical engineering, and product design. As program manager and division manager he has directed more than a dozen R&D programs, both for industry and for defense. Dr. Rothe holds several patents in laser technology and is author of over thirty-five papers published in peer-reviewed scientific journals, such as *Physics of Fluids, Journal of Quantitative Spectroscopy and Radiative Transfer, Physical Review, Applied Physics Letters,* and others. He has presented his research results at various scientific conferences. He is also the author of a philosophical book, *In Search of Truth and Freedom.*

*Rothe Technical Research, Cardiff, CA 92007;
E-mail: rtr@sand.net

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ECLECTIC OBSERVER

Compiled by Eugene Mallove

Spaceship Earth

The last issue's "Eclectic Observer" column began with an apt sentiment for the times—words by a military leader of the past, Army General Douglas MacArthur, who was associated with the "conservative" side of American politics. The following passage comes from "liberal" Democratic Presidential candidate, the late U.S Senator Adlai Stevenson:

> We travel together, passengers on a little spaceship, dependent on its vulnerable reserves of air and soil, committed for our safety to its security and peace, preserved from annihilation only by the care, the work, and, I will say, the love we give our fragile craft. We cannot maintain it half fortunate, half miserable, half confident, half despairing, half slave to the ancient enemies of mankind, half free in a liberation of resources undreamed of until this day. No craft, no crew, can travel safely with such vast contradictions. On their resolution depends the survival of us all. (1965)

Yes, that "liberation of resources undreamed of till this day" will truly come only when the most fundamental of commodities—energy—is free. All else for the good should follow.

Scientific American and Free Energy—1932

I have been saving this clip from *Scientific American* since July 1982. It is from the column, "50 and 100 Years Ago in *Scientific American*":

> July, 1932: "Just what may happen if physicists succeed in making available the incomparable energy within the atom—enough of it in a dime to drive a steamship across the Atlantic and back—is anybody's guess. In the famous Cavendish Laboratory at Cambridge University, Drs. Cockcroft and Walton have split the atom, releasing on a minute scale, but nevertheless releasing, far more energy than was put into the process. Although science cherishes and treasures every fragment of new knowledge of nature it can gain, in the present case there is unfortunately a possible by-product that might prove to be a doubtful asset to humanity. Sir Oliver Lodge thinks the young human race is still too primitive for this dangerous present. Perhaps humanity would not handle it judiciously. The control of such stupendous forces might also fall into the ruthless hands of the soldier-minded, and what fun it would provide for them while the human race and civilization lasted!"

Cold Fusion Critic in Hot Water

The New York Times of January 12, 2002 (p. A15), ran a story bannered, "UConn Officials Consider Dismissing Physics Professor—Scientist Is Accused of Threats and Insults." It concerned University of Connecticut physics professor Moshe Gai, who while at Yale University in 1989 figured prominently in the war against cold fusion. In his present imbroglio, Professor Gai, at UConn since 1994, is apparently in danger of becoming UConn's first professor in eighteen years to be fired.

Reporter Paul Zielbauer wrote, "University officials contend that his reputation notwithstanding, Dr. Gai has become a terror to his colleagues, students, and superiors, threatening and insulting them and engaging in behavior 'absolutely ruinous to his effective participation in departmental governance and activity.'" Gai, for his part, denies wrong-doing and says that his academic freedom is being infringed.

Referring to Gai's role in the cold fusion furor, the article erroneously states, ". . .he won national attention for helping to debunk an acclaimed theory of low-temperature nuclear fusion." Gai debunked *nothing* in 1989, and in fact performed an incompetent experiment that proved nothing, despite its being touted as a cover story in *Nature*, of July 6, 1989, pp. 29-34.("Upper limits on neutron and γ-ray emission from cold fusion.") He and his group did the usual straw man routine of trying to find neutrons and gamma signatures from an alleged Pons-Fleischmann-type cell. Their article ends with this untenable, illogical statement: "The absence of neutrons and γ-rays emitted from these cold fusion systems, together with the absence of a known mechanism for the suppression of reactions (1), (3), and (4), raises serious doubts as to whether cold fusion does occur in deuterided Pd and Ti metals at the rates suggested by Fleischmann *et al.* and Jones *et al.*"

I spoke with the Hartford-based *New York Times* reporter and then sent him this e-mail:

> Dear Mr. Zielbauer,
>
> Thank you very much for returning my call yesterday. I can understand that Moshe Gai's involvement with the cold fusion furor of 1989 may seem remote to the substance of your excellent story on his present UConn difficulties. Still, as the Gai story unfolds you may wish to explore this aspect of his scientific history. I am sure that other researchers in the cold fusion field (the term "low-energy nuclear reactions"—LENR—is the more generic terminology used today in view of expanded research findings) may be contacting you on this matter.
>
> The arrogance and roughshod ineptitude of Moshe Gai in 1989 foreshadowed perhaps his present difficulties at UConn. He and his group at Yale conducted a sham experiment that purported to set up the exacting conditions of the rigorously difficult Pons and Fleischmann heavywater/palladium electrolysis excess heat experiment. Gai's purpose was to check to see whether there were fusion neutron emissions from

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that cell as Fleischmann and Pons had initially reported (and which many other researchers have now since confirmed at low-level, though excess heat, not neutrons, is the primary signature of the cold fusion reaction). He reported finding no such neutrons, and thus condemned the entire corpus of the cold fusion work! Gai was not alone is such arrogant illogic: Imputing a "requirement" that solid state cold fusion operate like hot fusion at millions of degrees in a rarefied plasma and emit copious neutrons. (Furthermore, he did not even set up the electrolytic cell properly, so his work was doubly flawed.)

I and my colleagues suggest that the flaws in the context and implications of your article regarding cold fusion are:

1. The furor in 1989 concerned an experiment, not a theory.

2. The experiment was brutally attacked, not "acclaimed."

3. Gai cited preposterous theoretical objections to experimental results, which violates the most fundamental principle of the scientific method.

4. Everyone, including the discoverers Fleischmann and Pons, were well aware of these objections before Gai raised them.

5. The experiment was later widely replicated at a high signal-to-noise ratio at universities and national laboratories (both neutrons and excess heat), so the Gai hypothesis (and flawed experiment) is wrong to begin with!

In short, Moshe Gai played a significant role in helping to derail and set up for public mockery what may well turn out to be one of the greatest scientific discoveries of all time. (My memorandum to the Clinton White House—requested by it in February 2000, but not acted on, gives the overall conclusions. This memo is linked to on the home page of our magazine: www.infinite-energy.com)

Let me quote Gai from my book, *Fire from Ice: Searching for the Truth behind the Cold Fusion Furor* (John Wiley & Sons, 1991):

p. 144: "Our results exclude without any doubt the Pons Fleischmann results."—Gai at the Baltimore American Physical Society Meeting, May 1, 1989 in which Pons and Fleischmann were "hung" in absentia.

p. 162: Physicist Moshe Gai from Yale, an outspoken skeptic of all the neutron results, attacked Menlove's work and charged that even the Gran Sasso team was counting background gamma rays, not neutrons. "you cannot look for the effect with a background count of 100 counts per hour," he said angrily. There followed a free for all debate about whose neutron results were correct. Kevin Wolf criticized Moshe Gai's assertion that Wolf's detector wasn't suitable to measure the fusion neutrons." (I'll fax you more of the above exchange, which occurred at a DOE sponsored cold fusion meeting in MAY 1989. Further indication of Gai's arrogant, self-satisfied need to be center-stage.)

p. 169: The bearded and very biblical Moshe Gai matched Storms: "I would like to add to this a 'Thou shalt not. . .' The first 'Thou shalt not' is Thou shalt not use BF3 counters for neutron detectors."

The link to the UConn matter is that the arrogance exhibited by Gai and his ilk in 1989 derailed, albeit temporarily, clean abundant energy for the world—approximately 300 gallons of gasoline energy equivalent from each gallon of ordinary water! I'd say that that fact is far more important than whether Moshe Gai is allowed to continue working at UConn. I wish you and your science writer colleague at the *NYT* would give this matter an airing.

Dr. Eugene F. Mallove
Editor-in-Chief, *Infinite Energy* Magazine
Director, New Energy Research Laboratory

Free Energy Device from Ireland?

An electrical engineer in Ireland says that he has developed a free-energy machine, a dishwasher-sized device called the "Jasker Power System," according to a widely repeated story from the Reuters news service on January 22, 2001. The story was repeated on the websites of CNN and MSNBC, and Paul Harvey commented on it on his nationally syndicated radio program in the U.S. The inventor is not a "Mr. Jasker"—that name is a cover for his true identity, "for security and publicity-avoidance reasons," according to the account by Reuters' Kevin Smith.

The electro-mechanical device is started by a battery, whose energy is continuously replenished, according to the inventor, as evidenced in a demonstration for the Reuters reporter. Tom Hedrick, the head of a company that intends to license the device in the United States, spoke of the Jasker technology in glowing terms: "It's a giant leap forward. The uses of this are almost beyond imagination."

The inventor claims that he has provided all his own power needs free for seventeen months. The Reuters reporter commented: "If the Jasker men really are onto something, it could be the most important Irish invention since Guinness." Indeed, but so far there has been no independent verification of this device.

Curiously, at about the same time that this Jasker story was running, several other electrically over-unity devices (purveyed by U.S. claimants) came to the attention of our New Energy Research Laboratory. We have not yet had the opportunity to test any of these, but are awaiting the chance to do so.

Nucleon Cluster Model Developer Dies

Ronald A. Brightsen, the developer and ardent proponent of his "Nucleon Cluster Model" of the atomic nucleus, died December 20, 2001 at age 76 of liver and kidney failure. Brightsen headed the upstart company, Clustron Sciences, which was formed in 1992 and was based on the theoretical work that Brightsen had carried out since the late 1940s. Some of his technical work has been published by *Infinite Energy*.*

The Nucleon Cluster Model (NCM) is based on three bound clusters of protons and neutrons. Much more exotic than other cluster models, such as those put forth by Nobel Laureate Linus Pauling and others, the NCM attempted to account for

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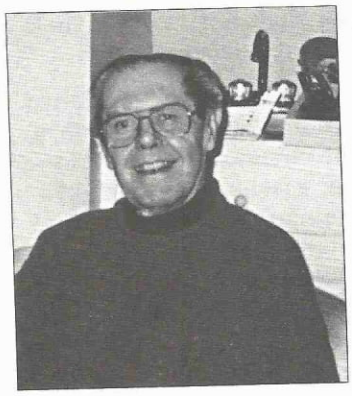

areas of nuclear physics heretofore unexplained by more conventional nuclear models—even as to the precise details of the nuclear fission fragment distribution curves. Brightsen for a time even believed his model could account for many of the anomalies being found in the cold fusion/low-energy nuclear reaction field.

Mr. Brightsen was of Norwegian decent and a native of Brooklyn, New York. He graduated from Wagner College in New York and went on to receive two Master's degrees—from the University of Michigan in Nuclear Chemistry and from MIT in Nuclear Physics. During World War II he worked as an analytical chemist on the Manhattan atomic bomb project at Oak Ridge, Tennessee. After World War II he was involved with nuclear weapons testing in the South Pacific and the effort to detect the first Russian nuclear tests. Brightsen also headed radiochemistry experiments for Westinghouse Corporation at the time of its development of the reactors for the first nuclear-powered submarine and for the first civilian nuclear plant. He was also the co-founder of a Pittsburgh-based company devoted to the peaceful uses of nuclear energy. Later, he joined the Nuclear Regulatory Commission (NRC) in 1976. In 1985, Brightsen retired from the NRC's safeguard division as an assistant director for licensing.

Brightsen is survived by his wife of 46 years, Martha Brightsen, of Reston, Virginia, four children (one from a previous marriage), and seven grandchildren.

[*Ronald Brightsen published the following papers in *Infinite Energy* magazine: "Application of the Nucleon Cluster Model to Experimental Results," Issue 3; "Nucleon Cluster Structures in Beta-Stable Nuclides," Issue 4; "Correspondence of the Nucleon Cluster Model with the Periodic Table of Elements," Issue 5/6; "The Nucleon Cluster Model and Thermal Neutron Fission," Issue 31.]

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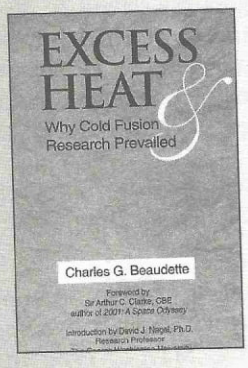

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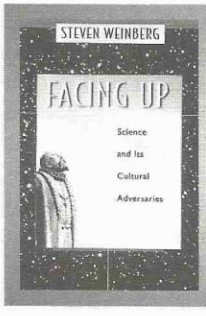

Facing Up: Science and Its Cultural Adversaries

by Steven Weinberg
ISBN 0-674-00647-X
$26.00 Hardcover, 283 pp.
Harvard University Press, 2001

Review by Eugene Mallove

In this collection of earlier published essays, physics Nobel laureate Steven Weinberg defends science, mainly physics—or at least *his* conception of physics, against its "cultural adversaries." Weinberg is perhaps the most outspoken advocate of the idea that physics is nearing a final "theory of everything," and that it is essentially impossible to conceive of a paradigm shift that would shake it (or any major part of it) to its foundations. He writes, ". . .I would argue that scientific theories share those properties of rocks—stability and independence of social setting—that lead us to call rocks real." (p. 269)

A recurrent theme in Weinberg's revealing essays is to criticize the late historian of science, Thomas Kuhn, whose analysis of paradigm shifts has become famous. To defend the permanence and supposed increasing perfection of physics, Weinberg writes: "I would say that physics in this century offers a remarkable example of stability." Indeed, the "stability" of a prison camp in which only the guards are allowed to speak or be taken seriously. So entangled is Weinberg in his experimentally detached labyrinth of mathematized physics that with no sense of humility he can write: "If (as I think) Maxwell's equations of electrodynamics and the theory of quarks are permanent parts of scientific knowledge that will survive all future revolutions in society, then how can we say that they are socially constructed instead of simply discovered." (p. 268) In another essay he writes, "Even though a scientific theory is in a sense a social consensus, it is unlike any other sort of consensus in that it is culture-free and permanent." (p. 135)

Weinberg does not fear that he may have become the perfect High Priest of dogmatic physics. This is especially ironic, since at every turn he rails against religion or anything that he imagines resembles, it, such as—yes, cold fusion! Weinberg is not faithful to the most elementary precepts of science, which is to say, he has not evaluated experiments before making a faith-based assertion about a class of phenomena of overarching importance to physics and society. So, why should we have much faith in his rock-solid belief in standard E-M theory or quarks? Weinberg mixes attacks against religious beliefs—such as the belief in "miracles"—with his lack of "belief" in cold fusion: "There do not seem to be any exceptions to this natural order, any miracles. I have the impression that these days most theologians are embarrassed by talk of miracles, but the great monotheistic faiths are founded on miracle stories—the burning bush, the empty tomb, an angel dictating the Koran to Mohammed—and some of these faiths teach that miracles continue to the present day. The evidence for all these miracles seems to be considerably weaker than the evidence for cold fusion, and I don't believe in cold fusion. Above all, today we understand that even human beings are the result of natural selection acting over millions of years of breeding and eating." (from *New York Review of Books*, October 21, 1999)

He says of this collection of essays, "They express a viewpoint that is rationalist, reductionist, realist, and devoutly secular. Facing up is, after all, the posture opposite to that of prayer." Only Weinberg could get up enough *chutzpa* to write this: "One of the great achievements of science has been, if not to make it impossible for intelligent people to be religious, then at least to make it possible for them not to be religious. We should not retreat from this accomplishment."

Weinberg admits the occasional obstruction by *prejudice* in science and that in his own case *preconceptions*—against experimental results!—turned out to be fortunate (at least in getting him the Nobel Prize, which we learn was conceived in the *front* seat of his red Chevy Camaro in Cambridge, Massachusetts on or around October 2, 1967!): "I know that I did some of my own best work because I had certain preconceptions about the way forces ought to work, and ignored experimental evidence to the contrary, and I did not succeed in taking the next step in this work because I was prejudiced against certain mathematical methods."(p. 6)

In another essay Weinberg writes, "The overwhelming success of Galileo's scientific achievement makes the injustice of his punishment notorious, but there are millions of others throughout history who have been punished for their views and teachings, and to whom regrets are also due." (p. 56) Yes, Dr. Weinberg, we await your regrets to the cold fusion and other physics heretic communities. With no sense of irony he suggests, ". . .at least within the areas of physics, which is mostly what I know about, and with this century [twentieth], whenever this consensus has been achieved, it has never been simply wrong. . .No consensus in the physics community has ever been simply a mistake, in the way that in earlier centuries you might say, for example, that the theory of caloric or phlogiston was a mistake. . .The exact sciences show a remarkable measure of resilience and resistance to any kind of hegemonic influence, perhaps more than any other human enterprise." (pp. 90-91) Really? The depth of Weinberg's illusions about his cultural milieu are quite amazing. In still another essay he writes, "The direction of physics today is overwhelmingly set by young physicists, who are not yet weighed down with honors or authority, and whose influence—excitement they stir up—derives from the objective progress they are able to make." (p. 152) Hah! Just let any such youngster try to submit a paper to his professor critical of Special Relativity or propose a theoretical justification for the data from cold fusion experiments. . .The punishment would be swift and firm. Even Nobel laureate Julian Schwinger learned that!

Though Weinberg avers that he knows much less about the biological sciences, he "knows" that physics—*his* physics—lies at the root of reductionist biological and

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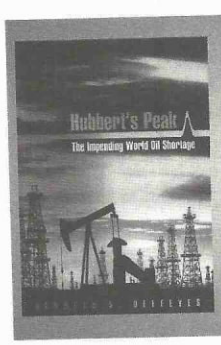
chemical paradigms.Thus he confidently puffs, "Henri Bergson and Darth Vader notwithstanding, there is no life force. *This* is the invaluable negative perspective that is provided by reductionism." He's on very thin ice, in grave danger of drowning in his bio-certainties.

Weinberg is steeped in his pretensions, after riding roughshod over realms of physics and biology with which he has an abysmal lack of understanding. All he has is his reductionist faith, a perfect filter against any experiment that might threaten to alter his preconceptions. He imagines that physics—as *he* understands it—is philosophically neutral! Weinberg: "The discoveries of physics may become relevant to philosophy and culture when we learn the origin of the universe or the final laws of nature, but not for the present."

In general, I would strongly counsel against reading this painfully bigoted tome—one that knows not its own bigotry. But if one wants to explore the essence of late twentieth century self-satisfied scientism, no better work may exist.



Hubbert's Peak: The Impending World Oil Shortage

by Kenneth S. Deffeyes
ISBN 0-691-09086-6
$24.00 Hardcover, 208 pp.
Princeton University Press, 2001

Review by Jed Rothwell

Kenneth Deffeyes makes a compelling prediction that world oil production will peak between 2004 and 2008 and begin declining inexorably. Since oil production began in 1859, people have periodically warned that oil will run out. They have always been wrong in the past, but the prediction must come true eventually, and our knowledge of geology and the remaining oil stocks is more accurate now. A century ago large areas of the Earth were still unexplored. Today there is not a single major valley or plain, on land or the continental shelf, which has not been mapped and prospected for oil.

Deffeyes bases his estimate of the ultimate limits on a famous production curve drawn by geophysicist M. King Hubbert in 1956. Hubbert predicted U.S. oil production would have a bell-shaped curve of distribution, peaking in the early 1970s. He turned out to be slightly optimistic. U.S. production peaked in 1970 at 10 million barrels per day, and it has now fallen to 6 million per day.

Deffeyes disposes of many myths about oil. Optimists claim that with better prospecting and extraction, we will find much more "hidden" or inaccessible oil. Economists, politicians, and futurists sometimes forget that there are physical limits to every resource, and nature does not bend to human hope. Some of the oil fields we have not yet drilled extensively may contain more than geologists estimate, but other surely contain less. Oil is only found in a narrow band, between 7,500 and 15,000 feet below the Earth. Below that, geothermal heat breaks oil down into natural gas. There is no oil beneath the deep ocean.

Deffeyes applies Hubbert's techniques to draw a curve of the world supply of oil, based on proven and estimated reserves. He predicts dire economic consequences if we do not prepare for the transition to renewable energy. I hope cold fusion pans out and erases the problem, but if it does not and we must tap alternative energy instead, the transition may not be as painful as Deffeyes fears. People in Japan and Europe cope with higher fuel costs than the U.S. Once the price of gasoline climbs to $3 or $4 per gallon, alternative sources of fuel will become cost-effective and may rapidly replace gasoline.

This production curve may seem a little like numerology, or fitting data into arbitrary curves without a theory. But a bell-shape is a common pattern of resource expenditure in nature and human society. The curve of coal production in Pennsylvania is a good example. It began in 1830, peaked in 1925, and fell close to zero by 1980. Hubbert and Deffeyes based their hypotheses on deep knowledge of geology, physics, and nuts-and-bolts technology. Deffeyes does not care for metasystems or abstract curve-fitting. Economists act as if oil and other resources spring up out of nowhere in response to market demand. A breakthrough will come when we need one. They think any limitation can be overcome when money is the incentive, as if nature can be bribed with dollar bills. Deffeyes proves that oil discovery has nothing to do with demand, or our improved ability to prospect. We found oil easily when it was plentiful, but for the last forty years we have found virtually none in the U.S. More U.S. oil was discovered in the decade from 1930 to 1940 than in any previous or subsequent era. Deffeyes writes: "A pop quiz for economists who insist that higher oil prices bring on discoveries: what did we call the 1930s? (The Great Depression) What was a price of oil? ($1 a barrel; without production rationing the free market price would have been 10 cents a barrel.)"

Deffeyes is a retired university professor, and a friend of the oil business. He grew up in the oil fields. As a consultant, he advised natural gas prospectors in western New York in a project that resulted in 100 successful gas wells, without a single dry hole. He introduces himself by writing, "As I drive by those smelly refineries on the New Jersey Turnpike, I want to roll the windows down and inhale deeply." He writes like the kind of professor who loves to teach. He exudes camaraderie for students. He revels in research and discovery. He describes the thrill of exploring ancient fossilized sand dunes, called "crossbeds," in Arran, Scotland: "My guidebook showed that Arran was about 10 degrees north of the equator during Permian time. That told me which way the tradewinds would have been blowing; the crossbeds were dipping exactly in the ancient downwind direction. I ignored the cold spitting rain and walked across those ancient sand dunes feeling the warm Permian tradewinds at my back."

The book is written in a conversational style, like a relaxed, witty lecture—the kind you remember vividly years after college. Deffeyes intersperses serious academic content with dozens of personal anecdotes, irrelevant asides, and

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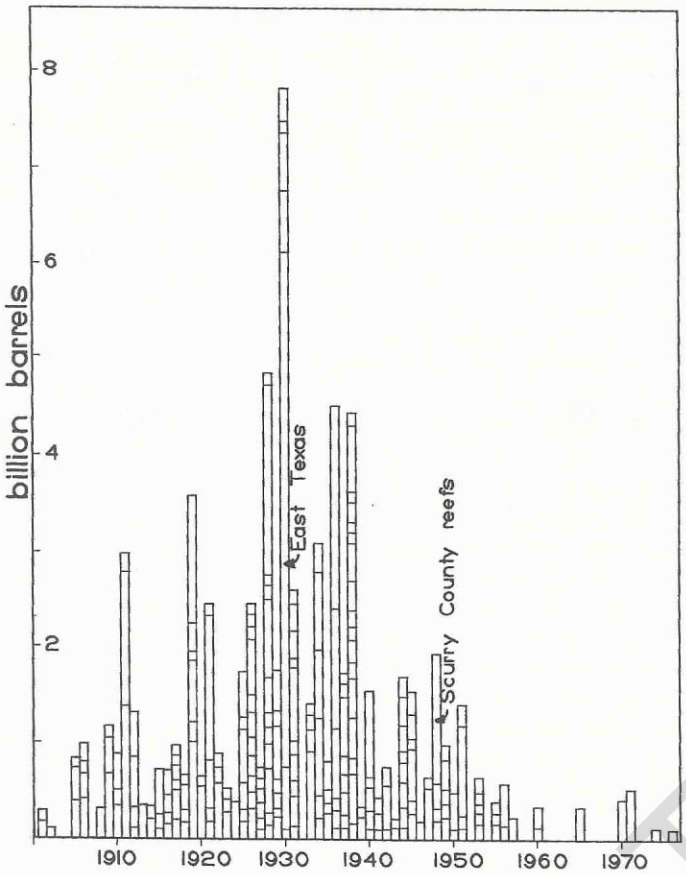

Discovery dates of U.S. oil fields exhibit a scattered but bell-shaped distribution. All oil fields larger than 100 million barrels on land in the lower 48 states are plotted against the year of the first successful well in the field. Despite the Great Depression, more oil was found in the decade from 1930 to 1940 than in any decade before or since. Notable large fields are East Texas (1930) and the Scurry County reefs (1948). [From *Hubbert's Peak*, p. 138.]

corny jokes. With a less gifted writer this would be a distraction, and it bothers some reviewers, but I find his style charming. Although the book is short and written for the general public, it includes a lot of meaty detail about geology, prospecting, drilling techniques, and estimating oil reserves. For those who crave more, every assertion is backed by extensive footnotes referencing technical papers.

Although the topic is dire, the book is not alarmist. Deffeyes makes no doomsday predictions of worldwide starvation or depression. He says we face a difficult technical challenge. We should act quickly, or it will cost us a great deal of money. He has no doubt that enough alternative energy exists to fix the problem, but he worries that people may panic instead of acting constructively. "Running out of energy in the long run is not the problem. The bind comes during the next ten years: getting over our dependence on crude oil." He warns: "During the 2000 presidential campaign, Democrats and Republicans debated about how to use the new surplus in the federal budget: pay off the national debt, fix Social Security, improve Medicare, or reduce taxes. There is another option: gift wrap the entire surplus and present it to the Saudi royal family. We could go happily on, pretending that either (1) a permanent decline in world oil production won't happen or (2) it doesn't matter. Ask anyone who remembers the 1980 crisis: it happens and it matters. In 1980 it was a problem in distribution; the oil was there, but it wasn't getting to the corner gas station. In 2008, the oil won't be there. The psychological realization that the change is permanent may be as devastating as the shortage itself." (p. 186)

Deffeyes' worst fear may prove right. People may succumb to panic and greed. A shortage may trigger a war, or increased use of coal, causing pollution and carbon emissions. Poor people may suffer while wealthy SUV drivers learn to shrug their shoulders and pay $5 per gallon for gasoline. On the other hand, professionals may buckle down and fix the problem while oil supplies are still ample. The Y2K computer bug was a serious and expensive problem, but it was fixed in time. The CEOs of Shell Oil, BP, Ford Motor, and other industry leaders have said that a transition to renewable, pollution-free energy is inevitable, and they are taking serious steps to implement it. Gasoline at $5 per gallon would soon drive people to conserve and find alternatives. Gasoline at $10 per gallon would spur changes almost overnight. Within a few years, society would be transformed the way it was to meet the crisis of World War II. Such excessive prices would rebound to destroy OPEC and the oil companies, the way the California power crisis hurt the power companies. The power companies price-gouged the public and made windfall profits for a while, but their shortsighted greed soon drove customers to reduce consumption. Conservation is permanent. Once a homeowner buys a new set of compact fluorescent lamps, or a factory installs new air-conditioning, they never again need as much electricity.

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The Economics of the Fossil Fuel/Cold Fusion Transition

Infinite Energy contributing editor Jed Rothwell submitted this letter to Ira Flatow, host of National Public Radio's "Science Friday" program, regarding his October 26, 2001 show on energy.

Dear Ira,

I enjoyed your October 26 show about energy, especially the comments about wind power. The technology has improved dramatically. I'm pleased to hear that congressmen and senators from states with a great deal of wind resources are now taking an active interest in tax policies.

Naturally, I wish that someone had mentioned cold fusion, but I suppose that is asking too much. Cold fusion is not dead yet. You have been talking to McKubre. He is not the only one with positive results. I recently returned from the third annual meeting of the Japan Cold Fusion research society (see the JCF3 conference report in *IE* No. 41), at Yokohama National University. Mitsubishi and the Italian National Physics Laboratory both announced dramatic results.

Anyway, getting back to your program, I would like to challenge one of the statements made by either Mr. Hoffman or Mr. Brown (I don't recall which) regarding how long it takes to change energy systems. I wish I could find the exact quote, but he said it takes a generation to switch over from one energy system to another because energy systems require a massive infrastructure, which cannot be replaced overnight. That has been true for the energy systems we had used heretofore, such as coal, oil, and fission power. These systems require large machinery and a distribution infrastructure. However, that may not be true for future energy systems. If something like cold fusion can be successfully developed, and the generating equipment can be made on a small scale, suitable for house, or a refrigerator, or a portable radio, then cold fusion might rapidly replace competing sources of energy.

Consider this scenario. Your home furnace wears out, and you go to Sears to buy a new one. You have a choice of a conventional gas-fired unit, or a cold fusion powered unit that costs a little more and pays for itself in one year. Naturally, you will select the cold fusion powered version. Within a few years, the manufacturers will no longer make the gas-fired version. Since home furnaces last fifteen years or so, after five years the natural gas companies will have lost one-third of their customers. They will begin to go out of business in droves, forcing other consumers to scrap gas-fired furnaces and install cold fusion models.

The same thing will happen with automobiles and other energy intense machinery where the cost to fuel is a significant fraction of the cost of ownership. When one-third of the automobile fleet is powered by cold fusion, gasoline stations will be unprofitable and many will close. Gas station profit margins are thin. Even a 5% drop in sales will put many of them out of business. A 30% fall in sales would be catastrophic, and it would bankrupt so many gas stations that long stretches of major highways would be without a gas station, which would force other motorists to adapt to the new technology.

There are many precedents for this kind of forced rapid-pace changeover when radically smaller, cheaper, or better products are introduced. The best example in modern times is the rapid switch from mainframe computers to microcomputers from 1980 to 1990. A changeover from coal to wind turbine electric power generation would be very slow, because wind power is only a little cheaper than coal even when you take into account the cost of health care and environmental destruction caused by coal. There is no compelling reason to rush and replace coal generators. Furthermore, the decision to replace them will be made by committees of regulators and corporate executives, and each decision will cost tens of millions of dollars, if not billions. The decision to replace an electric air-conditioner or a gas-fired furnace with a cold fusion powered version will be made by a consumer in a showroom, on the spur of the moment, after consulting with his wife. It will not be a billion dollar decision, it will be an extra $500. (There is no reason to think that cold fusion powered devices will cost substantially more than conventional ones.) Individual consumers often move much faster than corporations, especially when the decision is easy, risk-free, and the new product is substantially better or cheaper.

If cold fusion can be developed into a practical source of energy, I predict that ten years after the first cold fusion models are introduced, the major electric power, natural gas, and oil companies will all—without exception—face bankruptcy. Their expertise will not be needed. An oil company like Shell has no expertise in building home HVAC or small generators. Established companies like Tecumseh and Hitachi have been building engines for decades, so they will be well-positioned to build cold fusion engines. The engineering, customer support, marketing, and other business-related challenges will be similar to those of internal combustion engines, and very different from the kinds of problems Shell understands.

Finally, after the market stabilizes and cold fusion becomes the standard, there will far less profit in it than there was in oil. I mean five to six orders of magnitude less. Think about what Shell does for a living. They prospect, refine, and transport millions of tons of toxic, explosive chemicals. This is a remarkable accomplishment. They get paid well because what they do is difficult. It is hard to compete with them. You need expensive equipment, tanker ships, refineries, and thousands of highly paid experts. Building a cold fusion engine will someday become so easy that any start-up company with $10 million will be able to do it. The engines will be commodities, like today's personal computers. The fuel part (what Shell now supplies) will cost virtually nothing, and will bring in no measurable profit to anyone. A single low-level twenty-four-year-old technician will check the heavy water generator once a day, and his labor will replace the labor of ten thousand highly skilled, high income Shell employees.

Best Regards,
Jed Rothwell
Infinite Energy Magazine

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Light, Gravity, and Einstein's Twin Paradox: AN ARGUMENT FOR CLASSICAL PHYSICS

Paul E. Rowe

Introduction

This paper is based on a speech that I gave at the June 2000 meeting of the Natural Philosophy Alliance in Storrs, Connecticut. The speech is a digest of a paper that attempts to demonstrate that a concentrated matrix of protons and electrons remains when a system has been evacuated. The paper quotes highly regarded scientists and attempts to explain many physical phenomena on this basis. It proposes that the knowable universe is permeated with such a matrix (the ether).

Discussion

1. Christian Huygens

Huygens' "Treatise on Light" was published in 1690. It proposed that light (like sound) is a wave phenomenon transported through a medium of material particles. Huygens assumed that an evacuated bell jar does not carry sound because the medium for sound transmission is missing. Light is transmitted; so its medium must still be present.[1]

Huygens discussed an experiment of Torricelli, in which a glass u-tube, filled with mercury to a sealed end, was evacuated from the open end. The space that developed between the mercury and the sealed end transmitted light. Huygens concluded that the medium was still present. He further concluded that the medium easily passes through spaces between the atoms of the glass and/or the mercury. If so, the particles that make up the medium must be very small, indeed.

He compared the transfer of light to energy being passed from ball to ball in a series of suspended steel balls. At any time, all of the energy is on only one ball. Energy is transferred from ball to neighboring ball. The velocity of energy transfer depends on the physical properties of the material of the balls. Quoting Huygens:

> And it must be known that, although the particles of the ether are not ranged thus in straight lines, as in our row of spheres, but confusedly, so that one of them touches several others. This does not hinder them from transmitting their movement and spreading it always forward.

Huygens assumed that each activated ether particle passed all of its energy to neighboring ether particles. That is, each activated ether particle is the start of a new wave. On this basis, he developed equations that predict observed diffraction patterns. At the time, this was considered strong evidence of a material ether.

If Huygens had proposed that each activated particle passed all of its energy to one, and only one, neighboring ether particle, he could have predicted the photoelectric effect. Each activated ether particle (or group of particles) carrying a given frequency would have the same energy and would produce the same effects, regardless of the distance from the source of energy. That is, each photon transmitting a given frequency would have the same energy.

It would not be possible to predict which neighboring particle would become energized by an active ether particle. This may bear similarity to the Heisenberg uncertainty principle.

Fresnel patterns, discovered many years after Huygens' death, were found to conform to Huygens' equations. This was considered further confirmation of his material ether.

2. James Clerk Maxwell

Late in the nineteenth century, Maxwell developed the equations we still employ to predict the behavior of electromagnetic radiation. In developing these equations, he assumed the presence of a concentrated, material ether. The following quotes are from Maxwell:[2]

> In several parts of this treatise an attempt has been made to explain electromagnetic phenomena by means of mechanical action transmitted from one body to another by means of a medium occupying the space between them.

> According to the theory of undulation, there is a material medium which fills the space between the two bodies and it is by the action of contiguous parts of this medium that the energy is passed on, from one portion to the next, till it reaches the illuminated body.

> Let us next determine the conditions of propagation of an electromagnetic disturbance through a uniform medium, which we shall suppose to be at rest, that is, to have no motion except that which may be involved in electromagnetic disturbances. Let c be the specific conductivity of the medium, k its specific capacity, and u its magnetic permeability.

Using known values, including the speed of light, Maxwell calculated the permittivity (ϵ_0) and permeability (μ_0) of vacuum. Permeability is now associated with unpaired electrons. Could vacuum contain a high concentration of unpaired electrons? Common salt contains a high concentration of negatively charged chloride ions. The arrangement (whether liquid or solid) is stable because the same concentration of positive sodium ions is also present. Can vacuum be an arrangement of

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unpaired electrons and positively charged particles? This would lead to a simple explanation for the forces felt between two magnets.

I have not been able to find a reasonable explanation for such forces in the scientific literature. The relative dielectric constant (k′) of any material is its permittivity (ϵ) divided by the permittivity of vacuum (ϵ_0):

$$k' = \epsilon/\epsilon_0$$

If ϵ_0 was zero, every material would have an infinite dielectric constant. The relative dielectric constant (k′) of a material is related to the ability of charges in the material to adjust in such a way as to tend to cancel the effects of external charges. The dielectric constant of a material decreases dramatically with increasing frequency. At light frequencies, atoms cannot adjust fast enough and only electrons contribute to dielectric constant. The dielectric constant of vacuum appears not to change with frequency. This indicates that particles in vacuum react so fast to changing current direction that they respond similarly at all frequencies. This is further indication of the presence of electrons. I doubt that Maxwell's equations can be derived using the present theories of physics.

3. Clarence A. Skinner

The following paragraph summarizes the introductory page of a 1905 paper by Skinner:[3]

Skinner performed electrical discharge experiments in pure helium (2 torr.), using various metals as cathode. No matter how carefully he purified the helium, the spectrum of hydrogen consistently appeared in the cathode glow. At the same time, the pressure in the discharge tube continued to increase. On further experimentation, Skinner found that hydrogen was produced at the cathode and that the initial rate of pressure increase was that predicted by Faraday's laws of electrolysis.

Skinner's paper describes several interesting experiments. He produced thousands of times more hydrogen from a silver cathode than it could have contained; he noted, "It shows no sign of having its supply of hydrogen reduced in the least."

He discussed many surprising results. Metals, which tarnished during discharge in helium, soon slowed their rate of gas evolution. I have repeated such an experiment using a copper cathode. The pressure increased at the start of discharge. The rate of pressure increase then slowed as a dark coat formed on the copper cathode. Repeating the experiment at higher amperages caused the cathode to heat. The coat then formed on the inside surface of the glass discharge tube, in the vicinity of the cathode. This coat, which had the properties of cuprous hydride, became copper foil when heated in air.

It should be noted that helium is not reactive. None of Skinner's cathodes were expected to tarnish in the presence of pure helium.

Skinner noted that all metal cathodes tarnish on prolonged discharge in helium. On standing overnight, the tarnish on silver fell off, leaving a clean metal surface. Silver hydride is not stable and soon reverts to silver and hydrogen.

4. Sir J.J. Thomson

Many experimenters have reported the appearance of hydrogen gas in electrical discharge tubes. The following quote is from Thomson:[4]

> I would like to direct attention to the analogy between the effect just described and an everyday experience with discharge tubes—I mean the difficulty of getting these tubes free from hydrogen when the test is made by a sensitive method like that of positive rays. Though you may heat the glass to the melting point, may dry the gases by liquid air or cooled charcoal, and free the gases you let into the tube as carefully as you will from hydrogen, you will still get hydrogen lines by the positive ray method, even when the bulb has been running several hours a day for nearly a year.

I believe that Thomson's technique for ionizing gases produced hydrogen from vacuum. As long as he continued his discharge, he kept producing hydrogen by electrolysis of vacuum. This suggests that the positive particle in the ether is the proton and that the ether is a matrix of protons and electrons.

Such a matrix would account for the dielectric constant and permeability of space. The particles of the proposed ether are certainly small enough to easily pass through the spaces between the atoms of materials, as suggested by Huygens. The proposed ether would have considerable mass and the portion of the ether in the vicinity of the Earth, would tend to move with the surface of the earth, as does air. Since the Michelson-Morley interferometer moved with the surface of the Earth, no measurable ether wind should have been found in their experiments.

If scientists can produce hydrogen in an evacuated tube, it is not surprising that nature produces hydrogen in space, as a prelude to star formation.

5. George Musser (Scientific American editor)

The May 2000 issue of *Scientific American* includes an article by George Musser entitled "What's the Matter." This article discusses many suggested compositions of dark matter and gives reasons for rejecting each of them. The last paragraph of the article follows:

> Steinhardt and Spergel say everything works out if the particles have the same mass and interactivity as a neutron—an intriguing coincidence that, if substantiated, would be a huge breakthrough. The dark matter we perceive may be just a shadow on the wall. A mere hint of a vibrant world silently interleaved with our own.

The proposed matrix of protons and electrons may be considered a polymer of hydrogen atoms (possibly Bose-Einstein condensed hydrogen, which is expected to have zero viscosity). Though made up of charged particles, it would be neutral, in the sense that chemical salts are neutral. It seems to have the properties required for dark matter. A free neutron has a half-life of about twelve minutes. It decomposes into a proton, an electron and, theoretically, an anti-neutrino. The proposed ether would be expected to fill the spaces between atoms of materials and, therefore, might be considered as interleaved with our known world.

Many poorly understood physical phenomena (including the dual nature of light and action-at-a-distance) are easily explained, if space contains such a medium. The rest of this speech suggests the ether may be the medium for gravity and proposes a rational solution to Einstein's twin paradox.

6. Mass and Velocity

As an airplane approaches the sound barrier, more and more energy is required to impart a given acceleration. The mass of

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the airplane is believed to remain constant. A greater force is required because the medium through which the airplane is traveling increases its resistance to increased velocity. The medium for light may produce similar effects, as a rocket ship approaches the "light barrier."

Huygens suggested that matter is an open mesh through which the ether easily passes. However, as an object approaches the speed of light, the ether may have increasing difficulty moving around its atoms. If so, the energy required for imparting a given acceleration increases with increasing velocity.

If one defines a unit of mass based on a standard that is at rest, relative to the ether in its vicinity, one expects greater energy to be required to accelerate an object as the resistance of the ether increases. By this definition of mass, the force required to accelerate an object increases as the object approaches the speed of light. Its mass does not change.

7. Einstein's Twin Paradox

If materials that make up a rocket ship are porous to the ether, a pendulum clock in a rocket ship moves through the ether at a similar rate as the rocket ship itself. As the ship containing the pendulum approached the speed of light, the resistance of the medium to the swinging of the pendulum would increase. This would cause the period of the pendulum to increase and time, as measured by the clock, to decrease. The same effect would occur with modern time devices that are based on the periods of certain bond vibrations.

In the twin paradox, one twin remains on Earth while the other twin rockets away at close to the speed of light, turns around, and then returns at a similar speed. The speeding twins' clock would run slower in both directions of flight, since in each case it is moving rapidly through the ether. The earthbound twins' clock is comparatively still, relatively to the ether, and would indicate the passage of more time.

I prefer a definition of time based on a clock that is stationary, relative to the ether, in its vicinity. In order to determine the correct time, a factor, based on the speed at which a clock is moving through the ether (or, if you prefer, the ether is moving through the clock) would be applied to the time it registers. Time would, then, be more nearly universal and independent of velocity.

8. Gravity?

As Einstein predicted, light is bent toward the Sun when it passes close to the Sun. According to Maxwell's equations, this indicates that the dielectric constant of ether in the vicinity of the Sun is greater than the dielectric constant of free space. Recently, similar bending of light has been observed at surprisingly great distances from the edges of galaxies. If the dielectric constant of the ether decreases with distance from massive objects, light travels faster in deep space than it does within galaxies.

The weight of an object decreases as its distance from the Earth increases. This suggests a variation in the gravitational medium with distance from massive objects, similar to that of the medium for light.

Are the medium for light and the medium for gravity the same? If the electron portion of the ether is the medium for magnetism, could the proton portion be the medium for gravity? If so, there may be an attractive force between protons, which dominates when electrons have balanced electrical forces. The mass of an object is quite close to the mass of the protons and neutrons it contains. If one assumes that a neutron is made up of a proton and an electron, the mass of an object is very close to the mass of the protons it contains.

9. The Photon?

When a DC current passes through a straight wire, a compass needle near the wire points perpendicular to the wire. It remains so oriented until the current is stopped. This suggests that moving electrons in the wire cause ether electrons in the vicinity of the wire to orient. When the current is reversed, the needle points in the opposite direction.

At extremely low frequencies, the orientation of the needle changes with frequency. At higher frequencies, the needle of the compass cannot reorient fast enough, because of its inertia. Ether electrons have very little inertia and continue to orient with changing current direction, even at extremely high frequencies.

Let us consider a half-wave dipole antenna operating at a FM frequency. I understand that the current along such an antenna moves at the speed of light. According to Huygens' principle, each orienting ether electron passes all of its energy to a neighboring ether electron, etc. This effect moves away from the antenna at the speed of light.

As the direction of the current changes, a line of energy starts forming at one end of the antenna. Just as the direction of the current changes again, this line of energy leaves the other end of the antenna. The result is a line of energy moving through the ether at the speed of light (a photon). This line is in a plane of the antenna and at an angle of 45 degrees to the antenna.

When the direction of the current changes again, a similar line of energy (photon) is produced. This photon is also in a plane of the antenna but at an angle of 135 degrees to the antenna. Its ether electrons are orienting oppositely. What we consider one wave may produce a pair of photons. Each photon might be considered a mirror image of the previous photon.

At any instant, an integer number of active electrons are involved in a photon (there are no fractional electrons). For this reason, only specific amounts of energy can be carried as photons. This may be the basis for quantum mechanics.

10. Bose-Einstein Condensation

The January 1982 issue of *Scientific American* includes an excellent article by I.F. Silvera and J. Walraven, which discusses the possibility of atomic hydrogen forming a Bose-Einstein condensate at a temperature above absolute zero. In a Bose-Einstein condensate all of the atoms are in the ground state. The highest temperature at which the condensate is stable increases with the 2/3 power of its density. On this basis, a concentrated matrix of protons and electrons would be stable at extremely high temperatures.

The article points out that liquid helium below 2.18° Kelvin has strange properties and may be Bose-Einstein condensed. It is a superfluid. That is, it appears to have zero viscosity. Once set in motion, it continues to flow indefinitely. It flows through densely packed powders as if they were not present.

The spaces between the atoms of any material are about a thousand times the radii of the individual particles of the proposed matrix. Matter is an open sieve to such a matrix.

The December 2000 issue of *Scientific American* includes

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an article on Bose-Einstein condensates. Page 98 discusses experiments supervised by Daniel Kleppner of MIT towards producing Bose-Einstein condensed hydrogen. They were unable to detect any condensate until they employed spin-polarized hydrogen. I suspect that they had previously produced Bose-Einstein condensed hydrogen, but were unable to detect it. It is difficult to detect water you have produced in a lake. Spin-polarized condensate may have been different enough to be detected.

Conclusion

Assuming that the knowable universe is permeated with a zero viscosity medium (possibly, Bose-Einstein condensed hydrogen) leads to simple explanations for many otherwise difficult to understand phenomena. Such explanations may permit intelligent laymen to achieve a clear understanding of theoretical physics. They may also lead scientists to more efficiently direct their efforts.

Acceptance of such ether would require us to reconsider concepts developed based on the absence of an ether.

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About the Author

Paul Rowe has a bachelor's degree in chemistry from MIT and a doctorate in chemistry from Boston University. From 1953 to 1959, he was employed as Senior Chemist by the National Fireworks Company in Hanover, Massachusetts, where he experimented with explosives and propellants. From 1959 to 1980, Dr. Rowe was employed by Emerson & Cuming, Inc. in Canton, Massachusetts, where he was involved in research and development of plastic and ceramic materials for the electronics industry. In 1980, he retired as Director of Research and Development and has since been investigating the cause of strange results he obtained while detonating explosives containing powdered aluminum in vacuum. The explosions produced much more gas than was theoretically possible. His papers include some of the results of an exhaustive literature search and many experiments. Dr. Rowe was a consultant on electronics materials from 1981 to 2000. He retired in October 2000, but continues his private researches.

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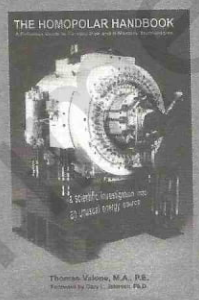

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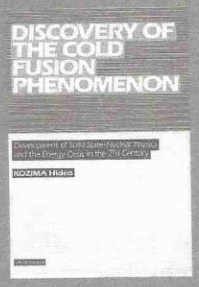

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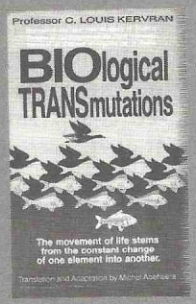

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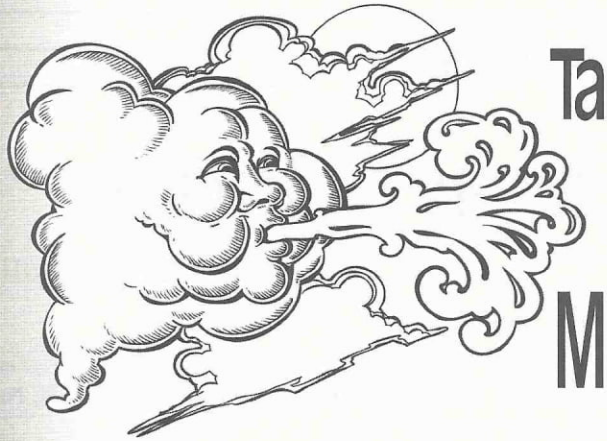

Taming the WEATHER MONSTERS

J. Gridelin

The August 12, 2000 issue of *New Scientist* features a story about a scientist named Ben Eastlund, who proposes using a beam of microwaves to disrupt a tornado. Thinking big never hurt anyone; it gives you a reputation as a visionary and if it doesn't work, you're probably saved from embarrassment by the fact that no one can afford to do it until after you're dead.

According to this article, the technique works in computer models. Computer models can be either very right or very wrong, depending on the accuracy of the information. But if the physics is correct and all the bugs are worked out, computer models settle down to a consistent picture of what would happen.

Around this time the scientist figures it's safe to publish.

Since many weather phenomena are caused by small differences in air density caused by humidity and temperature differences, it's theoretically possible to disrupt the formation of many a weather phenomenon by evening out the differences.

Eastlund's microwaves (beamed from solar powered satellites orbiting Earth, not available yet) would heat the cold, descending air in a tornado, completely discombobulating the circulation.

My understanding of tornadoes is incomplete, but this sounds good to me. Global warming will only breed more of them, and it's time someone did something.

The article also mentions hurricanes, which are my area of interest. In "Free Energy, More Fish, and Weather Control" (*IE* No. 33), I offer up the suggestion that ocean thermal conversion, a way of generating electricity from temperature differences in the ocean, would cool the ocean surface, slowing down the process of evaporation that causes hurricanes, after a summer of warming, in the late summer and fall. (Since warm air rises, and moist air rises, and warm, moist air rises so fast that hurricanes result.)

You'd need a lot of ocean thermal conversion generators, since the ocean is big and OTC generators are only about a megawatt each. (A hurricane, the New *Scientist* article states, unleashes more energy than the annual output of the entire U.S. power grid.) They'd also be located in the hurricane breeding ground, which is distinctly unsafe, and they have various environmental effects on eel breeding grounds and the Gulf Stream's warming effect on Scandinavia.

But never mind that. The article states that a chemist, Irving Langmuir, anticipated me by fifty-one years. In 1947 he dumped 100 kilograms of dry ice into a developing tropical storm. (The effect of dry ice—carbon dioxide—would be to increase the density of the air and not allow it to rise so readily, balancing the effect of water vapor.) He insisted this had an effect on the storm's track, though this was before the era of weather satellites and he was not widely believed.

The article says experiments with silver iodide, seeding the clouds, performed in the 1960s, had a similar effect.

People then wouldn't believe anything that small could influence anything so big.

People now believe in the butterfly effect, the snowball effect, the jumping-on-the-bandwagon effect, the domino effect, and any number of effects where small changes cause big effects.

So it could be that the weather monster could be tamed. Hurricanes, tornadoes, thunderstorms, plough winds—just understand the mechanism, whatever differences of density and heat are driving it, find some sort of monkey wrench to throw into it, and the world's your oyster.

But I like to consider an alternate universe. What if Georges Claude, the man who experimented with ocean thermal conversion off the coast of Africa in the 1930s or 1940s, had been forced to write an environmental impact statement about it, like I did. ("Seems to reduce hurricane intensity.") What if he'd talked to Irving Langmuir?

Obviously Langmuir understood the mechanism of hurricanes. If he'd connected them with ocean thermal conversion he might have been the Bill Gates of his time.

And we'd only hear about tropical storm Hazel, Andrew, Hugo, etc. If we heard of them at all. ❑❑❑

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BREAKING NEWS

New Sonofusion Claims in *Science*

Eugene F. Mallove

As this *Infinite Energy* went to press on March 5, a major development in sonofusion was announced—not by our laboratory or by Roger Stringham, but on the pages of *Science* magazine. Physicists at Oak Ridge National Laboratory and elsewhere, in what are being widely called "table-top fusion" experiments, published evidence of neutron emissions and tritium production in a deuterated liquid organic material (acetone—C_3D_6O) activated ultrasonically to produce cavitation bubbles. A neutron source was used to help create (*i.e.* nucleate) the bubbles. The piezoelectric transducer was outside the sonofusion cell, so no metal surfaces were in contact with cavitating bubbles, unlike sonofusion carried out in the cold fusion field. The authors did not attempt to measure excess heat, no surprise, because the entire context was that multi-million degree temperatures were being created in the cavitation bubbles, and thus mini-*hot fusion* of deuterons was being accomplished. They did not report any helium measurements being performed. We'll have much more coverage of this in the next issue of *Infinite Energy*, and probably on our website, but this is what we know at this time:

Science magazine will publish an article and a commentary about table-top sonofusion in its March 8, 2002 issue; it is a high-profile cover story. We congratulate *Science* and the authors for having the courage to publish this. The anomalous elevated ratio of tritium to neutron production reported in the article, which are already being dismissed by critics outright as indicating an experiment flaw, has long been a known characteristic of cold fusion systems. The articles are already being attacked—even before publication!—by the usual anti-cold fusion suspects (Park, Taubes, etc.). Some hot fusioneers who had *claimed* to have attempted the experiment properly prior to the article's release said that they did not observe the 2.5 MeV hot fusion neutrons.

These are the articles:

- "Evidence for Nuclear Emissions During Acoustic Cavitation," R.P. Taleyarkhan, C.D. West, J.S. Cho, R.T. Lahey, Jr., R.I. Nigmatulin, and R.C. Block, *Science*, Vol. 295, March 2002, pp. 1868-1873.
- Commentary: "Evidence for Nuclear Reactions in Imploding Bubbles," F.D. Becchetti, *Science*, Vol. 295, March 2002, p. 1850.

The *New York Times* of March 5, 2002 led on page A20 with a skeptical article, but the *London Sunday Times* (March 4, 2002) was much more upbeat and even quoted Martin Fleischmann. *Infinite Energy* readers worldwide are sure to find the general media filled with commentary and coverage about this.

Sonofusion (and sonoluminescence) is an area in which *Infinite Energy* has published since its inception in 1995. In fact, our first issue, March/April 1995, had Roger Stringham (now of First Gate Energies, Inc.) on the cover, cradling his sonofusion reactor. The cover story, "A 'Micro-Fusion' Reactor: Nuclear Reactions 'In the Cold' by Ultrasonic Cavitation," was by Tom Benson, Vol. 1, No. 1, pp. 33-37. There have been many other pieces, notably:

* "Cavitation in D_2O with Metal Targets Produces Predictable Excess Heat," by Roger Stringham, John Chandler, Russ George, Tom Passell, and Dick Raymond, *Infinite Energy*, Vol. 4, No. 19, April-May 1998, pp. 41-44.

* "A Progress Report: Energy Transfer in Cold Fusion and Sonoluminescence," by Nobel Laureate Julian Schwinger (Reprint of his Nov. 11, 1991 lecture at MIT), *Infinite Energy*, Vol. 4, No. 24, March-April 1999, pp. 81-83.

In more recent issues of *Infinite Energy* since November 2000 (Nos. 35-41), NERL's Manager, Kenneth Rauen, and I have chronicled our experience with Roger Stringham's sonofusion reactor, and our smaller modified reactor derived from it. The primary purpose of this work has been to identify the primary and most desirable signature of cold fusion/low energy nuclear reactions: excess heat, but we may now look for tritium too. Dr. McKubre's group at SRI International is now working with us to examine the possible helium production in this sonofusion reactor. Roger Stringham *et al.* have already found helium and other nuclear evidence in their sonofusion devices, in addition to observing melting under heavy water of normally high melting point metals.

The matter to celebrate the most in these *Science* articles is the apparent discovery of yet another particular system for producing fusion reactions. And we certainly celebrate that the experiments are, indeed, "table-top"—just like most cold fusion experiments. Of course, the work reported in *Science* needs to be reproduced in its particular form, just as cold fusion experiments had to be and were reproduced, repeatedly. But on first examination, the work appears to have been done very thoroughly. It is immediately apparent that sonofusion work carried out in the cold fusion/low-energy nuclear reaction (LENR) field, although not referenced by these authors, can provide significant support in both experimental and theoretical aspects. We imagine that the authors were not aware of much of this work.

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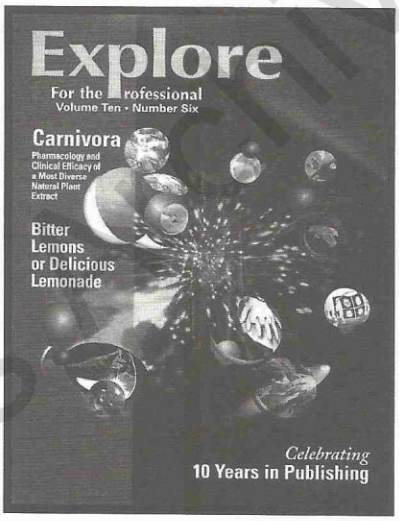

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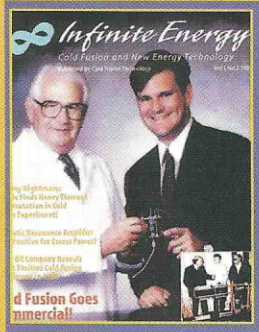

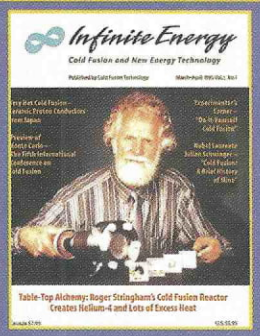

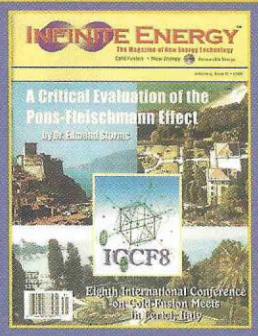

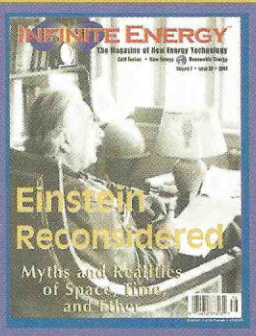

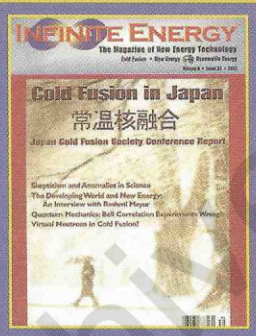

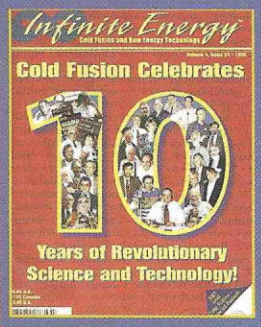

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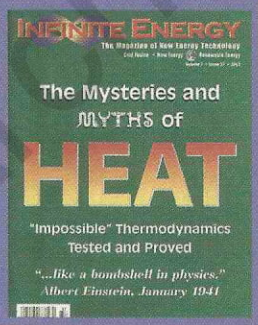

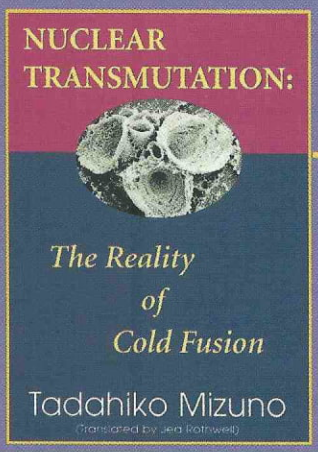

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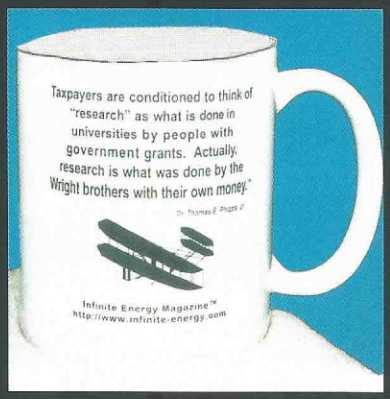

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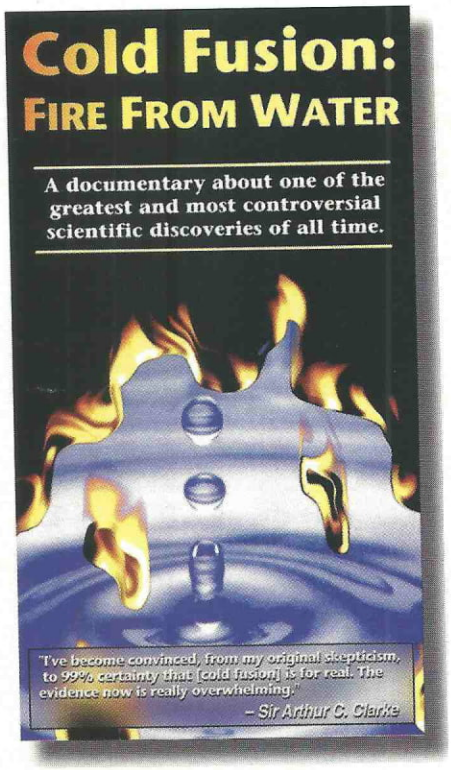

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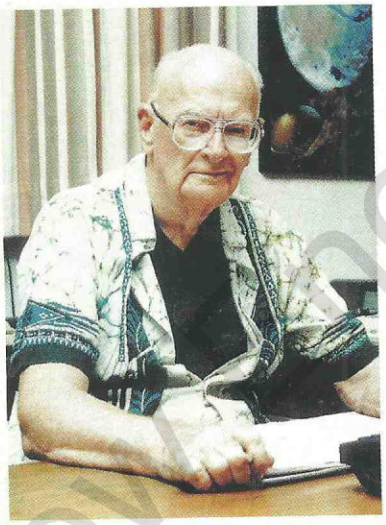

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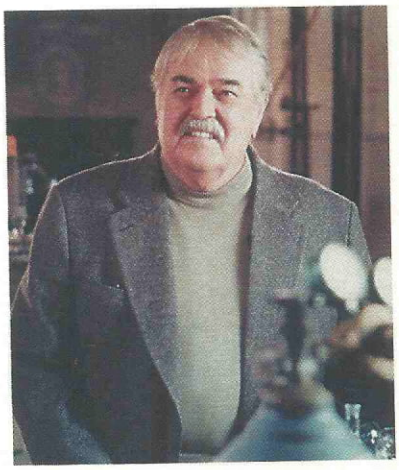

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